THE ENGINEER

A Seven-Day Journal

Fuel Research

IN our issue of December 15, 1950, we reviewed the report of the Fuel Research Board covering the years 1939 to 1946, which had then just appeared. The latest report from the Board, dealing with the period April 1, 1946, to March 31, 1949, was published by H.M. Stationery Office last week. It records the transition from short-term wartime researches to post-war reconstruction projects. An immediate task after the war was the repair of damage at the Fuel Research Station at Greenwich and the construction and installation of plant and equipment needed for the post-war programme. The greater part of that programme is concerned with the more efficient use of fuel, both domestic and industrial. The report says that experiments have been undertaken on the gasification of fine, low-grade coals and cokes, using the "fluidised-solids" technique, with a view to providing producer gas, water gas and gas for the synthesis of oils. It is suggested that if producer gas made in this way was used for heating retorts in gas works, additional quantities of large coke could be made available for other purposes. Reference is also made in the report to the fact that some of the advantages of oil fuel can be achieved by burning coal in pulverised form. Special burners for pulverised fuel, which have been designed at the Fuel Research Station, are being widely used in industry and the station is now engaged on the design and development of combustion chambers to enable coal to be used to provide the energy for gas turbines. Other work described in the report includes the part taken by the Fuel Research Station in an investigation, sponsored by the Boiler Availability Committee, to overcome the difficulties caused by deposits of solid matter on the external heating surfaces of power station boilers. It is stated that the laboratory work and the full-scale experiments in power stations associated with this investigation have already yielded valuable information. Finally, there is a mention of the continuing study of the Fischer-Tropsch process and its modifications as a means of producing oils and chemicals from coal.

Education for Management

THIS week the Anglo-American Council on Productivity has issued a report by a specialist team which has recently visited the U.S.A. to study education for management. The team was led by Colonel L. F. Urwick, chairman of the British Institute of Management's education committee. The team spent about six weeks in America, during which time its members visited thirty universities and colleges, seven other institutions, eight trade unions, and fifty industrial and commercial undertakings. The various sections of the report deal with the American educational picture, education for business management, the schools of business administration, liaison between business and education, and executive development. The team considers that a major contribution of the American universities to management education is their provision of advanced training programmes for high-level business executives which are designed to overcome the handicap imposed by the high degree of specialisation in modern business and to broaden the outlook of the man with experience in predominantly one function who may be required to move on to top-management responsibilities. Members of the team were much impressed by the flexibility of the American university system and by the desire on the part of educationists to ascertain and meet the real needs of industry. In its conclusions, the team says that in recent years there has been an enormous expansion of the provision, in universities and elsewhere in the U.S.A., for training in administrative studies to prepare suitable men to take their place in management at all levels. The team thinks that American experience shows that productivity and education for management are closely related. It considers the subject to be of such great importance to this country that British industry as a whole should study means for promoting educational experiments for executive development. Individual firms, it is suggested, should review their training programmes in the light of American experience and education authorities should consider how they can best encourage and develop administrative studies.

The Electricity Corporation of Nigeria

THE Electricity Corporation of Nigeria, which was established by an ordinance of the Nigerian Government, has given an outline of its proposed development programme. It may be recalled that on April 1st last, the corporation took over the electricity undertakings formerly operated by the Nigerian Government. It will shortly absorb similar undertakings now owned by some of the native administrations. The existing power stations consist of steam and diesel generating installations without any interconnections, many of the stations being in isolated townships, difficult of access. The new development programme will involve the improvement of existing stations, and the erection of new stations, including one of high capacity at Mamu River, close to the coal mines, with a transmission network connecting Lagos, Ibadan, Abeokuta, Oshogbo, and other areas in the Western Provinces. It is also proposed to link up Port Harcourt, Aba and possibly Calabar in the Eastern Provinces, with the new grid, and to extend a service in the direction of Abakaliki to serve the lead and other ore mines and a new large cement works. In the Northern Provinces, at Kano, an extension to the existing power station and distribution system is already in hand, some of the equipment being almost ready for shipment. It is hoped to complete an important portion of this programme by 1956 up to which date some £11,000,000 will be expended. Further development will take place in the provision of hydro-electric power stations at suitable centres when the necessary resource research has confirmed their practicability. The Corporation has its headquarters at Ijora, Lagos, and maintains a liaison office in the United Kingdom at the Corner House, Great Peter Street, London, S.W.1.

International Institution for Production Engineering Research

THE developments which are taking place in production engineering techniques and the existence of numerous production problems have led to the formation of an International Institution for Production Engineering Research. Its aims are: to promote scientific research into the mechanical working of all solid materials; to establish permanent contact between investigators by comparing research programmes and exchanging experimental results, and to convene conferences for consolidating research results. The titular members of the Institution are limited in number and are elected from research workers who have distinguished themselves in the field of machining of materials. The first technical meeting of the Institution was held in September under the chairmanship of Monsieur Portevin, who has been elected president, when reports were presented by General Nicolau, general secretary of the Institution, on the measurement of surface finish, and by Professor Bickel on the measurement of cutting temperature. The next meeting is to be held, during the first half of 1952, at Louvain, Belgium. Arrangements are being made for discussions on the statistical definition of the metrological criteria of measuring instruments, and on the subject of grinding with special reference to the influence of working conditions on the finish of ground surfaces. Research workers who have investigated, or who propose to investigate, the problems discussed at the last meeting, or those which are to be discussed at the next meeting, are invited to send four copies of their papers by February 1, 1952 to the secretary, General P. Nicolau, 233, Boulevard Raspail, Paris, 14e.

The Building Exhibition

THE Building Exhibition at Olympia opened on Wednesday, November 14th, and will remain open until next Wednesday, November 28th. This year the exhibition has 425 stands, and is the largest show since it was first introduced in 1895, occupying all three halls at Olympia for the first time. Every phase of the building and allied trades is covered by the exhibition, with the exception of furnishing. The exhibition includes several stands devoted to the work of government organisations, such as the Ministry of Works and the Department of Scientific and Industrial Research, as well as those of the numerous private firms which are exhibiting. The exhibition was opened by the Minister of Works, Mr. David Eccles, who commented upon the wide range of materials, equipment and ideas which had been brought together to point the way to cheaper, quicker, and more beautiful building. Efficient expansion was the keynote of the exhibition, he said, and the nation had never needed greater output more than now.

Single-Phase 50 c/s Electric Traction Trial in the U.K.

LAST week the Railway Executive announced its decision to carry out a trial of the single-phase, 50 c/s system of electric traction on British Railways. This trial will be made on 9½ route-miles of the Lancaster–Morecambe–Heysham line, which was first electrified experimentally at 6·6kV, 25 c/s, in 1908, since when the useful life of the equipment has expired. With the help of the principal electrical manufacturers various methods and various kinds of equipment are to be tried out and the overhead line voltage will be varied from the present 6·6kV up to and including 22kV. This system of traction, in which power is fed directly to the trains at high voltage and the standard grid frequency, was recommended in the British Transport Commission's recent report "Electrification of Railways," as being suitable for consideration on secondary lines, the recommended system for lines carrying heavier traffic being 1500V direct current. The single-phase, 50 c/s system introduces special problems, such as difficulties with commutation, but it has several advantages, including the use of a lighter overhead system, fewer and simpler substations, and the absence of power cables alongside the track. Recent technical advances, resulting particularly from important development work and trials that have been proceeding for more than a year on the French Railways (THE ENGINEER, Feb. 2, 1951, p. 154) suggest that the new traction system may now have a wider field of economic application. The proposed experimental electrification by British Railways will provide experience of the suitability of power frequency a.c. electrification for conditions in this country.

The End of an Era

By EDWARD H. LIVESAY

No. II—(*Continued from page 612, November 16th*)

THE track from Vancouver is double for upwards of 100 miles, and the speed was 45–50 m.p.h. between stops. The usual running routine went on in the cab—sand was fed through the firebox to scour oily deposit from the flues—a blow-down apparatus operated, with coloured lamps indicating electrically the presence or otherwise of surface scum—occasionally the other blow-down by the foundation-ring was let go, and so on. The signals received from the conductor by the air-communication system were acknowledged by repeating them on the steam whistle and appropriate action taken. Fireman Tombs said that about twenty-four barrels of fuel-oil would be used to North Bend, the equivalent of eight gallons per mile. As is often the case, the temperamental steam-chest and exhaust-pressure gauge was out of kilter, only the former needle doing its duty. Lee made the common complaint: "I don't know why they fit the thing—nobody pays any attention to it! I can run an engine without looking at needles on a dial—I can *feel* when things are O.K.—it's too delicate." All it told me was that with the throttle well open—it was never fully so—when the boiler-pressure was near the proper figure, 275 lb, and it generally was, the steam-chest pressure was not far off, and that was that! Interesting, but scarcely worth providing a special gauge to indicate. With the ease of control conferred by oil-fuel the pressure was seldom far from popping-off point and now, I think of it, I cannot positively recall a single instance during the whole week of travel of a safety-valve blowing while we were running, which surely speaks volumes for oil-firing, and also bespeaks the care with which the firemen watched the manipulation of the throttle and shut-down on the oil, simultaneously with the closing of the former. A fireman behind a shovel has a very much more difficult task; often he has to attempt the impossible and a valve will lift in spite of anything he may do.

Mission, 43 miles, is in the heart of the fruit and dairy country, and packing plants and saw-mills are dotted all along the line; at Agassiz there is a Government Experimental Farm, and also the station for Harrison Hot Springs, mecca of the rheumatic. The Coast Range, the first barrier the line penetrates, looms up ahead, fir-clad as to its base, its 4000ft peaks glistening pink and white against a blue sky. It was quite warm in the sun but sodden, rotting snow was still piled along track and road, marking the trail of the blizzard of ten days before. The Fraser had looked a strangely unimpressive stream up to this point, a narrow ribbon meandering about among mud and gravel flats, but no doubt it would take on a very different aspect when the snows melt in the mountains, becoming a mile-wide sheet of swirling, yellow water. At Ruby Creek the track singles, the gradient stiffens, and the exhaust takes on a more determined note. The Kettle Valley branch goes off to the south at Katz, along with the Coquihalla River, its valley providing a right-of-way. We are out of the Fraser delta now, in among the mountains, and "rocks and Christmas-trees," the B.C. trademark, pervade the landscape. The trans-Provincial highway appears alongside, here as a good paved thoroughfare; at Yale it merges with the old Cariboo trail or what was known as such in the eighteen-sixties, when it was used by tens of thousands of miners, who slogged along the dusty, rutted wagon-road to the fabulous Cariboo gold fields. Navigation ended at Yale then and still does; Hell's Gate (Fig. 4) stopped it and the "Devil's Washbasin,"—the first a rocky cleft, from the train looking only about 50ft wide, through which the Fraser foams, the second a whirlpool—the river was very low and yellow here. At Yale, too, No. 2390's riding became decidedly rough, beyond peradventure; I was told the track here was responsible for the riding. The C.N.R. came in sight on the other bank, nearing its first divisional point at Boston Bar, so at this place, through a narrow defile, two railways, the river and the road all find passage.

FIG. 5—DAY COACH WITH RECLINING CHAIRS, C.P.R.

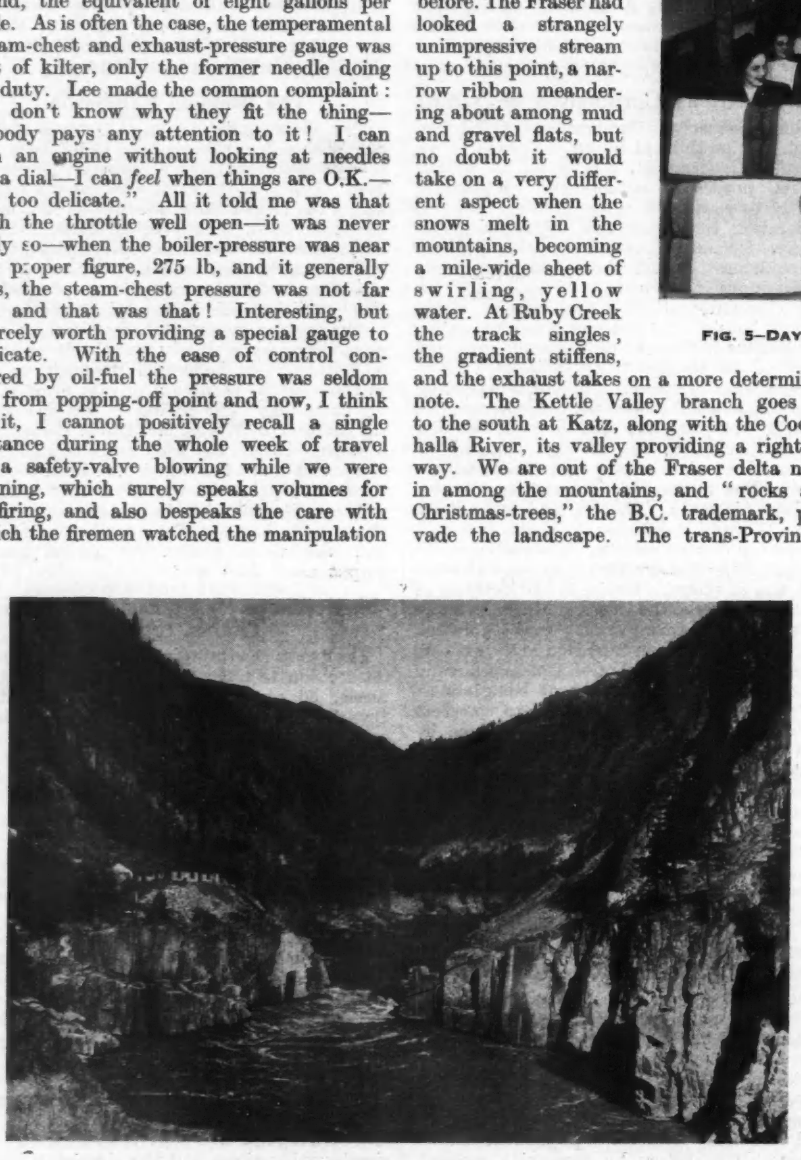


FIG. 4—HELL'S GATE, FRASER CANYON, B.C.

The decaying remains of the old road suspension bridge span the Fraser near Spuzzum, and the railway enters a tunnel several hundred yards long, the longest, I should say, until the 5-mile bore through the Selkirks, the "Connaught," is reached at Glacier, 300 miles ahead.

It was a perfect "Swiss" day by now, of blue sky and sunshine in a snowy mountain setting; the omens were favourable for a pleasant run. Nearing China Bar—the very name brings up pictures of the gold-rush days—the road crosses the canyon by a modern suspension bridge and shortly afterwards "No. 2" came to a stand at North Bend, the first divisional point, on time at 2.25 p.m., and Lee and Tombs handed over to Gray and Nicholson, Kamloop's men.

Divisional points, where engine-crews change, "ground-crews" attend to lubrication (grease), brake-gear, &c., are 125–150 miles apart; ashpans are cleaned where coal-burning locomotives are concerned. There was time for a hurried snack at the lunch counter before coming back to the cab to introduce myself to the new crew, "No. 2" pulling out at 2.42 p.m. During the run from Vancouver No. 2390 had earned my respect as a rugged, powerful engine, well up to its duties, the only blemish being the rough-riding mentioned before, but that was merely a matter of adjustment not poor design. The class is very similar in dimensions and power to the 2800 "Hudsons" employed on the "Dominion," but fitted with a single axle "Cartazzi" trailing truck instead of the four-wheel Bissell and the drivers are 5in smaller. In fact, the class is a development of the 2700 "Pacifics" I rode out of Vancouver thirteen years ago on the same train. Naturally the "Hudsons" are better riding engines; no "Pacific" is ever likely to be as well-behaved as one boasting a four-wheel trailing truck, so I was not disappointed that

No. 2390 was not being exactly diesel-electric in action; I only regretted she needed shopping! I should mention that these "Pacifics" are not fitted with boosters, which endow the "Hudsons" with 12,000 additional pounds of tractive effort.

North Bend roughly acts as the dividing line between the moist coast region of B.C. and the interior "dry belt," and as soon as we were running well clear of the place it became evident; there was less snow alongside and on the mountains above. Passing Kanaka, Gray pointed out some gold washing being done on the sand banks left bare by the shrunken river; apparently it is still possible to "make wages" at this monotonous occupation: hope still springs eternal in the human breast. At Cisco, nearing Lytton, the C.N.R. and C.P.R. change sides; we cross over to the south bank, and for a while the track runs east, instead of north, which it had been doing more or less ever since leaving Haig. Here we leave the Fraser and pick up the Thompson, following along its Black Canyon towards Kamloops. Gray and Nicholson kept a keen look-out for falling rocks, displaced from high above by the first spring thaws and unseasonable rains; we were running mostly on a narrow shelf blasted from the canyon walls. Apparently the C.N.R. on the other side was in trouble of some sort, two freight trains standing there, patiently waiting for a go-ahead order; their crews and Nicholson exchanged comradely greetings across the water. When serious difficulties crop up over these divisions the two companies pool their resources, and the one not affected extends the hospitality of its track to the cripple; the connecting link is at Kamloops. When both go out of action simultaneously, as was the case last winter, the Kettle Valley line is left as the only rail connection with the east, and when that, too, is *hors de combat*, Trans-Canada Airlines is the sole survivor. You fly, or stay at home; I would certainly do the latter.

Through the "Jaws of Death" gorge, where the Thompson River is forced into angry turmoil by the constricted channel, "No. 2" proceeded O.T. to Spence's Bridge, but here progress was halted—there was a wash-out ahead. A little stream high up the mountains, suddenly swollen by a few mild days, had undermined the track some miles distant, and a work-train was being hurriedly assembled and rushed to the scene. We watched it go, wondering how long it would be before "No. 2" was given the "high-ball." Exchanging confidences in the cab, poking round the engine and train, visiting a restaurant across the road, we waited, but the halt threatened to be of indefinite duration as the hours passed, so I retired to a reclining chair in the first coach (Fig. 5) knowing nothing more until awakened by the conductor with the news that we should be pulling out shortly, and if I wanted to get back to the cab I had better collect my wits and notebook and go. A whole sheaf of "orders" was being discussed by the enginemen—"meets," "slows"—down to 5 m.p.h. over the wash-out—and so on, and we got under way at 10.22 p.m., the night clear, frosty and starlit, the headlight throwing its white beam far along the track, tunnelling through the blackness, a great safeguard against the dangers of rocks and wash-outs, lurking just round some bend, threatening our safety. It was good to get going again after six hours of immobility, but immediately the difficulty of taking notes after dark became evident, despite the shaded lamp high up at the back of the cab casting its carefully directed rays of light on to the various gauges, and I began to get bored, as usual. Had "No. 2" kept to the schedule I should have been in Sicamous by this time, able to stop off for a good night's rest, and to carry on with "The Dominion" in the morning at 6.50. As it was, there was nothing but darkness ahead, and if I stopped off anywhere I should miss No. 5935, "Selkirk" (Figs. 6 and 7) the C.P.R.'s last steam locomotive, which was to be put on "The Dominion" at Revelstoke specially for me—or for THE ENGINEER, rather—next morning. Getting back to the train for some sleep

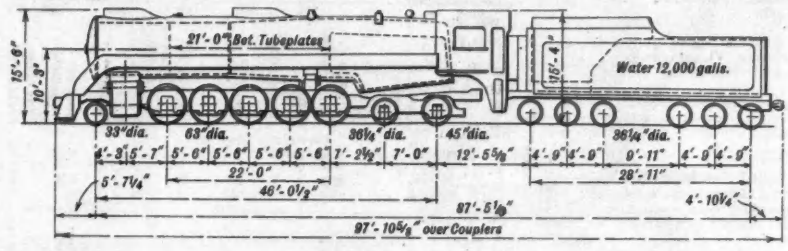


FIG. 7—OUTLINE T1B CLASS

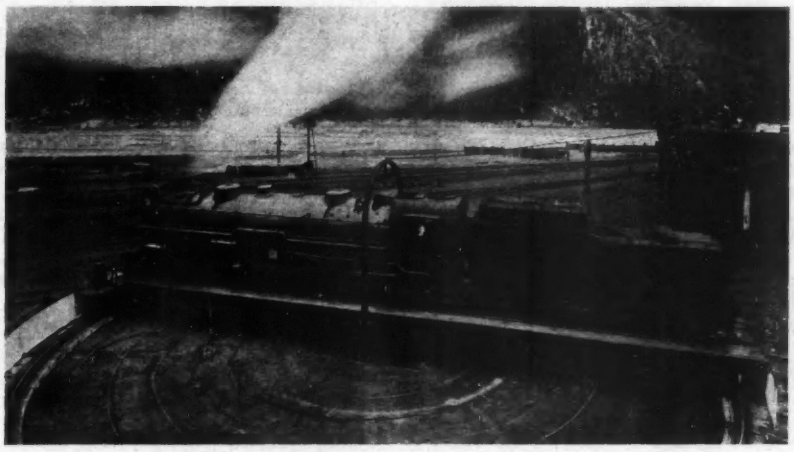


FIG. 8—ENGINE NO. 5905, T1A CLASS AT FIELD

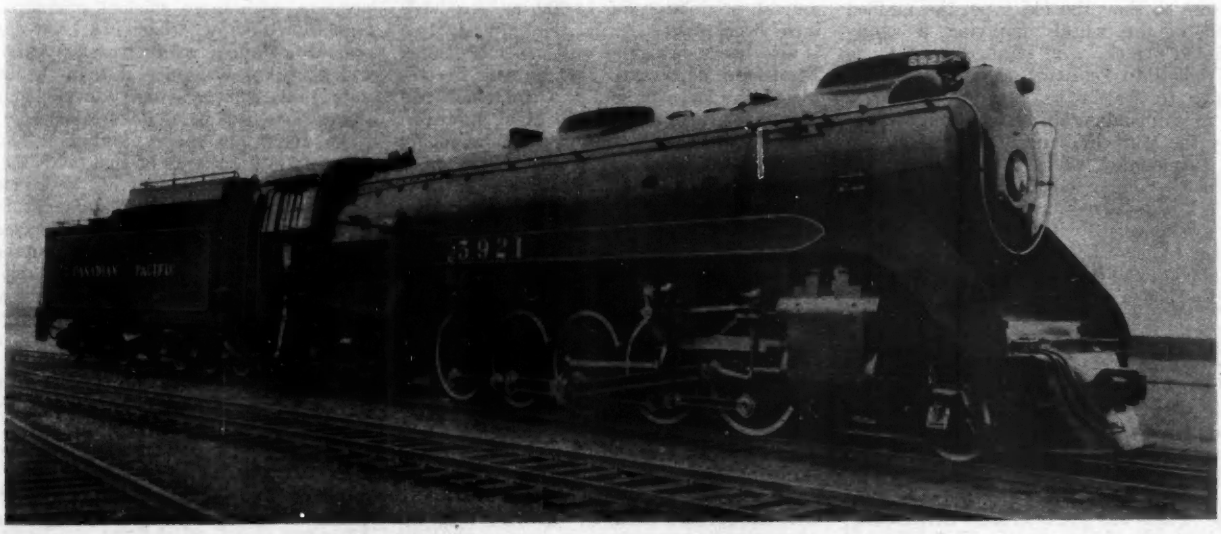


FIG. 6—ENGINE NO. 5921, CLASS T1B, "SELKIRK" TYPE

seemed the most sensible thing to do, especially when another long stop "in the hole" (at a siding) at Spatsum, to await the passing of two freight trains, threw us still more behind, and I again sought the "reclining chair"—incidentally, a big improvement on the old fixed seat—until Kamloops was reached at 3 a.m., 7 h 20 min late. There virtue triumphed, and I made a brief reappearance in the cab, to be introduced to the new crew, Messrs. Spencer and Olund. Finding shortly after we had got under way, by falling asleep and pitching out of my seat on to the deck, that I was doing no good whatever in the cab, except amuse the crew, I decided to go back to the coach at the next stop, and this time *stay* there until we reached Revelstoke. The last notes made before I did so record that for a few miles there seemed to be no snow at all, and then we ran into it again; also that the speed was considerably higher, 50–55 m.h.p.; not, it was evident, an attempt to make up time, which was hopeless, but to keep well ahead of No. 8, "The Dominion," probably pounding along, not far behind, and likely to overtake us. At Canoe, nearing Sicamous, I awoke—in the coach—to find dawn near at hand, the train spinning along beside Shuswap Lake, under a grey sky, the ice still solid; pure, unadulterated winter—it might have been mid-January, not March. The car ran very smoothly and quietly, far more so than the old type, the muffled rumble of the wheels implying a snow-blanketed track. A strange winter, so mild right into February, then exploding in violence to scatter its pent-up fury over 1500 miles of mountain and prairie. Apparently the stiff climb over Notch Hill had been surmounted while I slept without a "pusher" coming on; I know the crash and jerk of its arrival and the restart would have awakened me with a guilty feeling that I ought to have been in the cab at such a crucial point had one been used. At Sicamous a cup of coffee put some fresh life into me, but not enough to make me exchange a reclining chair in the coach for a stuffed seat in the cab. So, from the car window I watched the Craigellachie cairn flash by in the pink dawn, the granite obelisk where in 1885 Donald Smith, afterwards Lord Strathcona, drove the last spike marking the spot at which east and west construction gangs met, and the transcontinental C.P.R. came into being. There was plenty of snow hereabouts; the nearby road was walled in by it, and every stump had its mushroom-like cap of white. We were running along beside the Eagle River, between the Hunter and Gold Ranges, nearing the Three Valley incline, but this, too, was surmounted without assistance. And so over the Columbia, here wide and shallow, into Revelstoke, coming to a stand at 8.00 a.m., more than 7 h late, where I was disappointed to find that No. 5935, the *piece de resistance*, was not rostered for either "No. 2" or "No. 8," because, in the two weeks' interval between my first abortive attempt to make the run and the later successful essay, the promise to put her on a daylight train for my benefit was forgotten. No. 5935 was actually standing in the yard at the moment, but not ready for action, so there was nothing to be done but await the arrival of the "Dominion"—also running late, about two hours—and go on with whatever engine Fate and the Roundhouse might ordain for that train. This turned out to be No. 5921 (Figs 6 and 7) of the same class, in charge of enginemen Mold and Belding, with one of the older 5900s ahead, No. 5904, acting as pusher. "The Dominion" pulled out at 10.40 a.m., the two great engines, weighing together upwards of 700 tons, with boosters vigorously putting their shoulders to the wheel, tackling a 2 per cent gradient up through Box Canyon, climbing towards the summit of the Selkirks at Glacier, and trailing a load of 1300 tons. To cap everything, in the distraction of a platform conference with the Superintendent and Master Mechanic as to what could ultimately be done about No. 5935, none of us noticed that the "high-ball" had been given, and that "The Dominion" was on the move, which called for a grab at a handrail and swinging aboard the nearest coach. So I left Revelstoke, the gateway to the most interesting and spectacular part of the whole route, at the beginning, of all divisions, of the one over which I should have been on duty, not merely cut off from the engine I had come so far to travel on, but not in the cab at all! Disgusted, I sat looking out at the snowclad mountains and the rushing waters of the Illecillewaet, thinking what a mess I was making of things, until fortunately a "flag" stop gave me a chance to flounder through the trackside snow and reach No. 5921.

(To be continued)

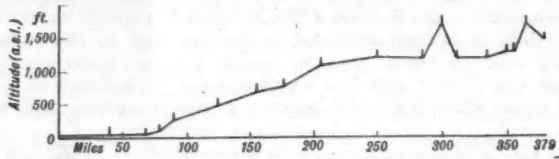
Average speed (booked) inclusive, Vancouver-Revelstoke, "Dominion," 29·9 m.p.h.

Average speed (booked) inclusive, Vancouver-Revelstoke, "No. 2," 25·7 m.p.h.

Average speed (actual) inclusive, Vancouver-Spence's Bridge, "No. 2," 26·8 m.p.h.

Speed restrictions are imposed throughout, safety of operation being paramount over this difficult route.

Double-heading is generally necessary over the Notch Hill and Three Valley inclines, "pushers" being provided at these points.



Timetable														
"No. 2"	"Dominion"	VANCOUVER	Mission	Agassiz / Ruby Creek / Hatg	North Bend (Division)	Lytton	Spence's Bridge	Ashcroft	Kamloops (Division)	Chase	Notch Hill / Tappen	Sicamous	Craigellachie / Tgft / Three Valley	REVELSTOKE (Division)
10.00 a.m.	7.30 p.m.		6.35	9.37	11.30 arr. 11.40 dep.	12.41 a.m.	1.27	2.18	3.50 arr. 4.05 dep.	5.04	5.40 (f) 5.57 (f)	6.50 arr. 7.00 dep.		8.35 a.m. arr.
10.00 a.m.		11.29	12.19 p.m. 12.38 12.53		2.25 arr. 2.40 dep.	3.45	4.30	5.27	7.05 arr. 7.15 dep.	8.28	9.13 9.35	10.40 arr. 11.00 dep.	11.45 (f) 12.12 (f)	12.45 a.m.
Actual Time														
10.00 a.m.		11.28	12.21 p.m. 12.38 12.57		2.25 arr. 2.42 dep.	3.43	4.35 arr. 10.22 dep.		a.m. 3.00 arr. 3.23 dep.			6.23 dep.		8.00 a.m. (7 hrs. 15 m. late)

Schedule disrupted due to washout.

FIG. 9—VANCOUVER TO REVELSTOKE

Hydro-Electric Power in the Isere Catchment of the French Alps

No. I

THE resources of hydro-electric power in France are, in the main, situated in the three mountainous regions of the Pyrenees, the Massif Central and the Alps. In the future a major source of power will be the River Rhone, where projects with a total annual production of 14,000 million kWh have been planned,* and power production is also being developed on the River Rhine, Electricite de France having nearly completed the large project of Ottmarsheim on that river. At the present time, however, hydro-electric production in the third region is obtained principally from Alpine tributaries of the Rhone of which the two most important are the Isere and the Durance.

The projects on the Isere River and its tributaries, which are reviewed in this article, are considerably more extensive, and present a greater interest both technically and historically, than those of the Durance. In fact, from the point of view of the hydro-electric engineer, the Isere catchment is the finest in France and is probably unique in the great variety of its power developments. It drains the highest mountains in France, with the exception of the Mont Blanc massif, which is drained by the River Arve. Industrial activity in the valleys of some of the tributaries, such as the Arc and the Romanche, was combined with the early development of numerous hydro-electric plants, which to-day, stretch "head to tail" along the greater part of these valleys. The present tendency is to replace such installations by much larger projects, with more efficient operation and regulation of flow, which has been done in several instances within recent years, and will doubtless be done again in the future, now that comprehensive development of the catchment is being undertaken.

An important point to-day in French economy is the saving of coal, with the consequent encouragement of hydro-electric construction. The Isere catchment is one of the areas which have been selected for extensive development, and a number of projects, some of them of considerable size, are at present in the course of construction or in the design stages. The principal power developments of the area are shown in the accompanying illustration, Fig. 1.

The table below gives the installed capacities and estimated outputs of schemes recently completed, under construction or in the design stages. By comparison, the installed capacity of projects under construction or investigation for the North of Scotland Hydro-Electric Board totals about 1050MW, with an estimated annual yield of

* See THE ENGINEER, December 8, 15, 22 and 29, 1950.

power of some 3000 million units, and the corresponding figures for schemes at present built or under construction for the Board are nearly 430MW and 836 million kWh. The power produced by existing schemes in the Isere catchment last year was about

TABLE I.—*Recent Power Developments in the Isere Catchment (See Fig. 1)*

Power stations recently completed or under construction	Installed capacity, MW	Annual production, kWh × 10^6
La Vanelle	33	147
Pont-en-Royans	22	100
Peage-de-Vizille	58	280
Pontcharra	13	41
Aiguebelle (Randens)	117	477
Arvans	27	90
Aussois	90	325
Pralognan	51	170
Ugine	40	148
Malgovert	320	630
Les Brevieres	108	150
Totals	879	2558
Projected power stations :		
St. Hilaire	33	225
Beauvoir	30	180
Armieux	67	500
Sassenage	7	30
N.D. Comiers	200	750
Cognet	64	300
Romanche Superieure	120	380
St. Nazaire	40	235
St. Helene	47	275
Mont Cenis	400	1000
Champagny	155	257
Moutiers (Isere)	135	505
Moutiers (Champagny)	300	554
La Bathie	320	750
Les Mottets	10	43
Roselend	12	35
Le Chevril	20	75
Totals	1960	6094
Total under construction and projected	2839	8652

4210 million kWh, the corresponding amount for the Durance catchment being 581 million kWh from seven power stations, and for the total hydro-electric production in France about 16,000 million kWh (total power production from all sources about 33,000 million kWh).

The hydrology of the Isere catchment

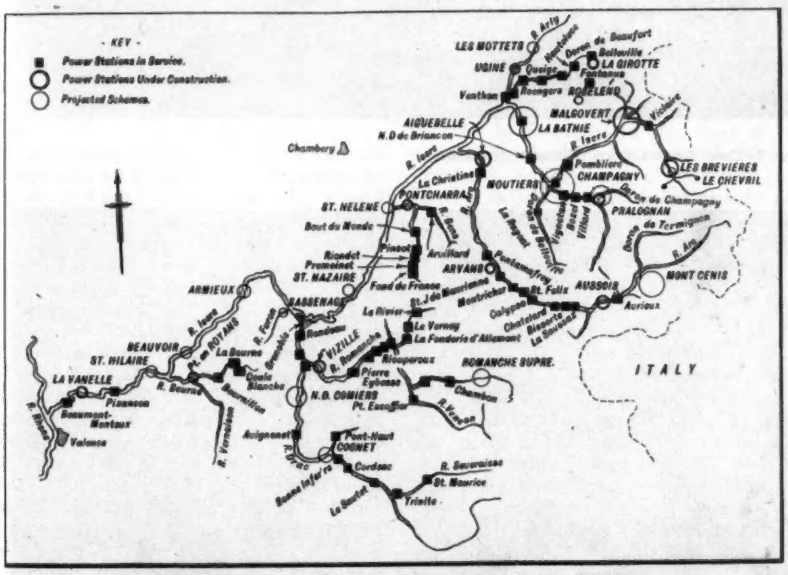


FIG. 1—POWER DEVELOPMENTS IN THE ISERE BASIN

generally follows a glacial regime, many streams being fed by glaciers. The flows vary (through a ratio of 10 : 1 in the upper reaches) from a minimum in January to a maximum in July. Thus the generation of firm power demands seasonal reservoirs to make good the low winter flow; however, in years of low rainfall the flow is sustained by an increase in the rate of melting of the ice, caused by the higher temperatures which are characteristic of the dry periods. This hydrology, which is also a characteristic of the rivers of the Pyrenees, has encouraged the development of the Massif Central, where the flow is a maximum in winter and early spring. The run-off in the Massif Central, where the heads do not as a rule exceed 600ft, is not generally sufficient for base load operation of the plant installed throughout the year, but production can be conveniently combined with that of the other regions.†

By contrast, the run-off in the Isere catchment is generally more reliable, being affected less by dry periods for the reason given above; the heads may be in excess of 1000m. Some typical figures for the river may give a general idea of its potentialities. On the upper Isere—at Les Brevieres, for example—which is at an altitude of about 1600m, the rainfall is about 40in per year, and the average flow 8·2 cubic metres per second.‡ The minimum flow is 3·1 cubic metres per second, and that of the greatest flood known 43 cubic metres per second, whilst the total flow in a year is about 255 million cubic metres, of which nearly two-thirds occurs between May and September. On the lower part of the river at La Vanelle about 20km upstream from the confluence with the River Rhone, the altitude is about 130m and the mean flow 350 cubic metres per second. The minimum flow at La Vanelle is 120 cubic metres per second, and the largest flood about 2900 cubic metres per second. The catchment area supplying the Tignes dam is about 415 square kilometres in extent, its average altitude being 2300m; the corresponding figures at La Vanelle are 11,533 square kilometres and 1450m. Table II gives a typical

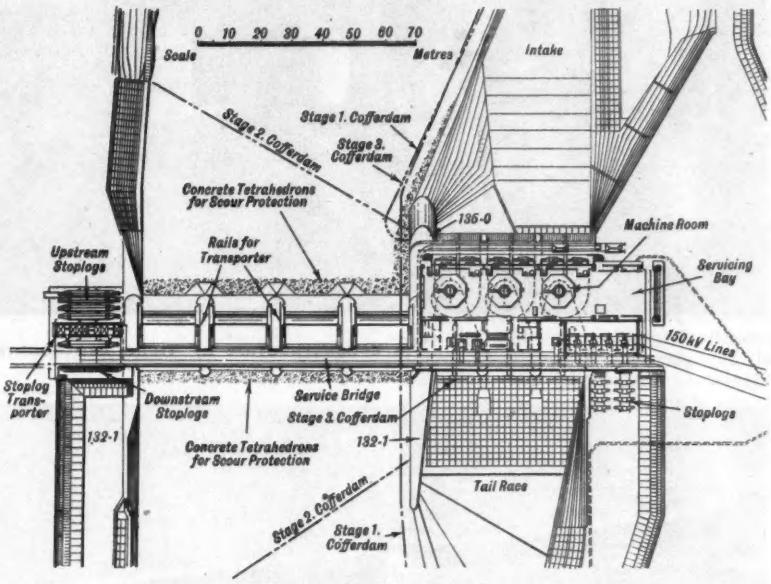


FIG. 2—BARRAGE AND POWER STATION OF LA VANELLE

TABLE II.—*Mean Monthly Flow of the River Drac at Le Sautet*

Month	Cubic metres per second
January	16·6
February	17·9
March	27·6
April	43·8
May	60·3
June	62·8
July	36·8
August	20·5
September	25·0
October	30·9
November	33·6
December	20·7

set of monthly flow figures. As may be seen from the above figures, the seasonal flooding may be severe; it is typical of Alpine streams and persists throughout the catchment.

Apart from the problems which the Isere presents from the hydro-electric point of view, model studies have also been carried out at the well-known laboratory of "Neyrpic," at Grenoble, on the length of river immediately upstream and downstream of Grenoble, with a view to cutting canals across the necks of several large meanders to improve the flow characteristics, especially in times of flood, and hence to improve generally the irrigation of surrounding agricultural land and reduce the extent of possible flood damage in the neighbourhood of Grenoble.

LOW-HEAD PLANTS

On the lower reaches of the river, between the confluence of the Rhone and the Isere just north of Valence, and the tributary La

† The plants of the Massif Central were described in our issues of August 19 and 26, and September 2, 9 and 16, 1949.

‡ 1 cubic metre per second = 35·32 cusecs. 1m = 1·09 yards.

LA VANELLE POWER STATION ON THE ISERE RIVER, FRANCE

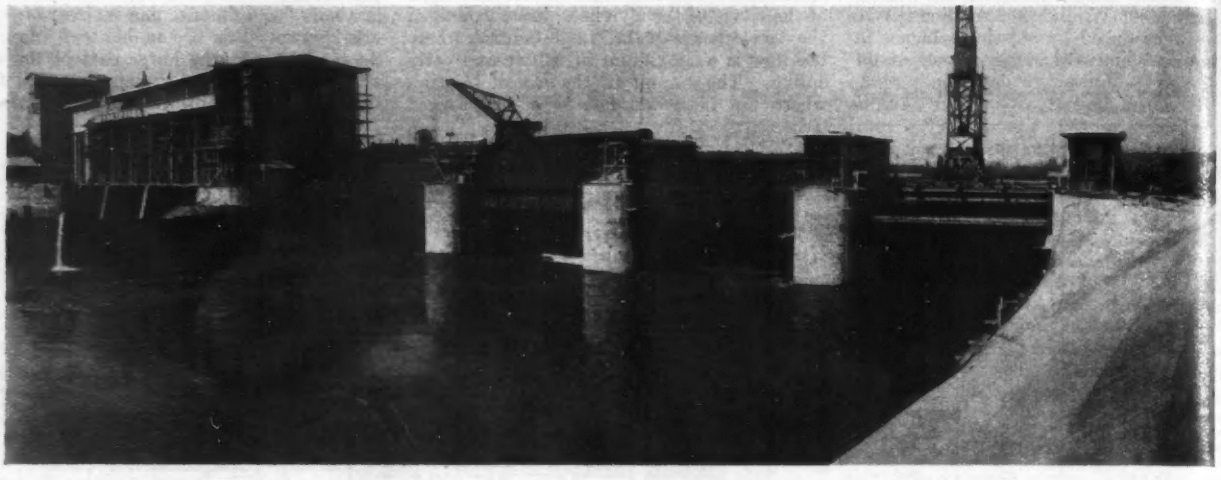


FIG. 4—CONSTRUCTION OF THIRD AND FOURTH STAGES

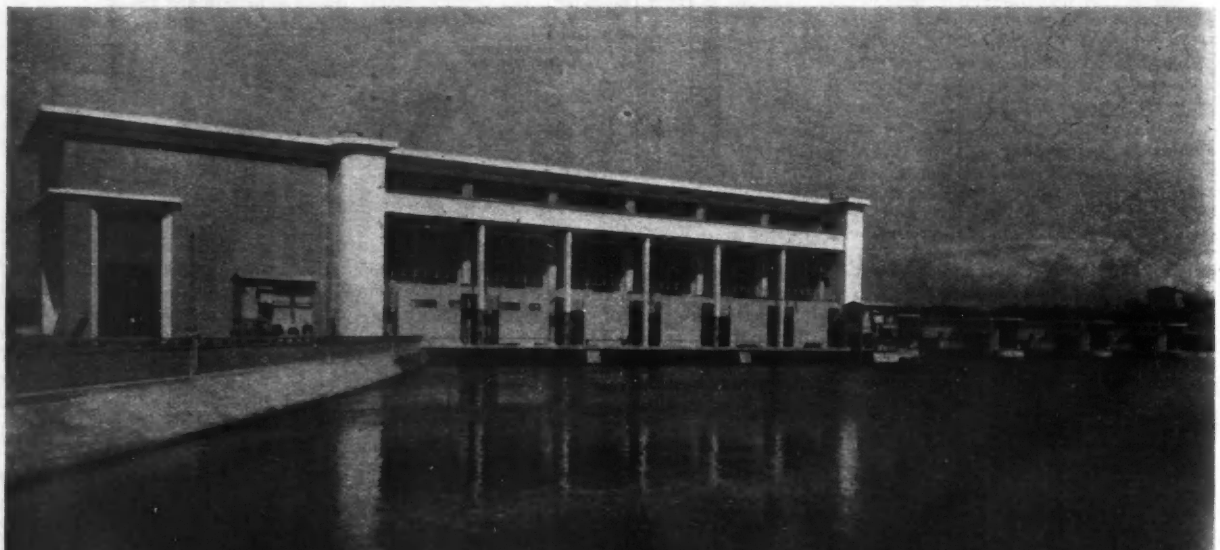


FIG. 5—THE COMPLETED POWER STATION

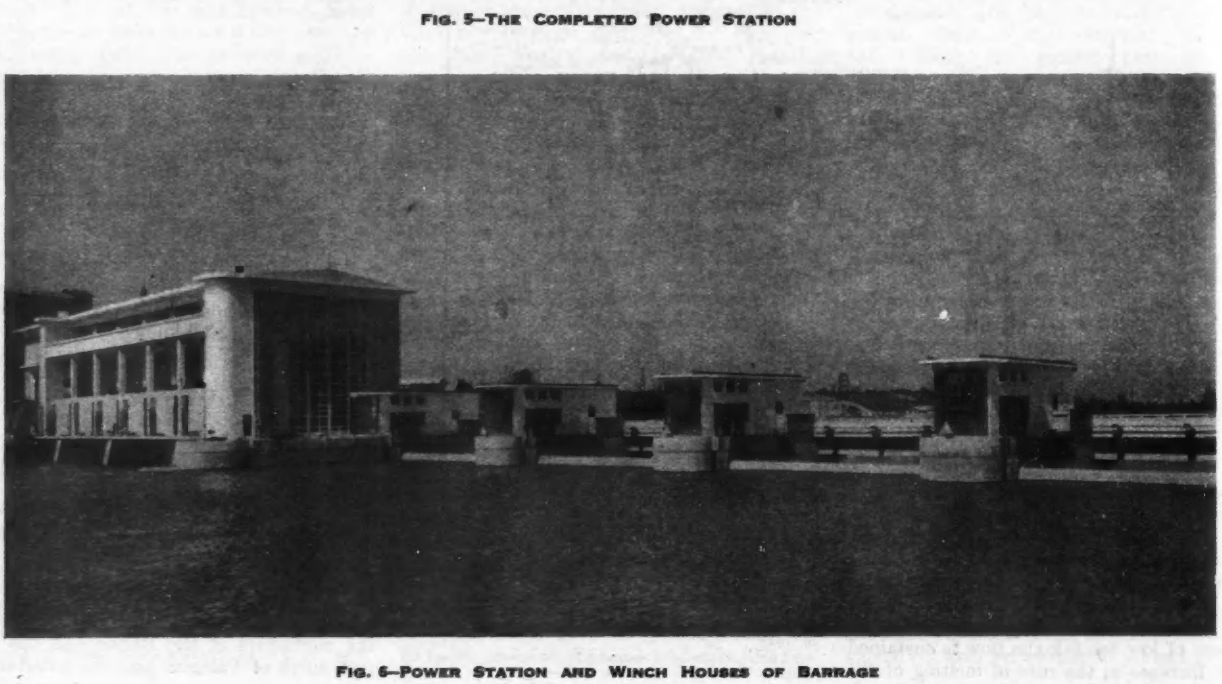


FIG. 6—POWER STATION AND WINCH HOUSES OF BARRAGE

Bourne, are three low-head installations, Beaumont-Monteux, La Vanelle and Pizançon, which at present are the only power stations on the Isere downstream of Grenoble. The first turbo-alternator set at La Vanelle was put into service in the middle of 1950, and the project was substantially completed by the end of that year. It utilises a head of between 6m and 8·75m the upstream level (137m) being that of the tail-race of the power station of Pizançon

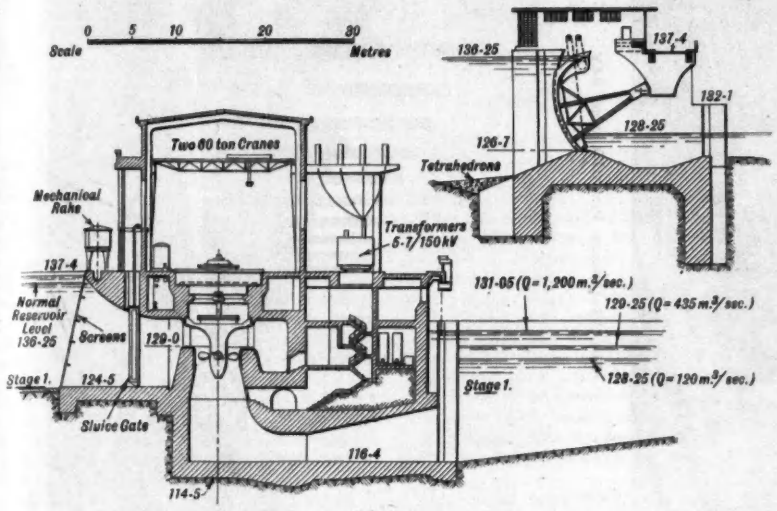


FIG. 3—LA VANELLE BARRAGE AND POWER STATION

about 8km upstream. Works are at present in progress to raise the impounded level of the head-race of the Beaumont-Monteux power station by 1m to the level of the tail-race at La Vanelle.

The oldest power station of the three is Beaumont-Monteux, which was built in 1920. There is a barrage across the river at Chateauneuf d'Isere, and a head-race canal on the right bank leading to the power station 1½km downstream. The available head is about 11m, and there are seven sets of machines totalling 40MW in the power station. Originally Francis turbines were installed, but they have now been replaced, with one exception, by fixed blade or Kaplan turbines.

Pizançon barrage and power station was built between 1928 and 1932. A maximum head of 12·5m is utilised and the annual power production is about 220 million kWh. The power station is on the right bank of the river and contains four 12·5MW sets, there being two Kaplan turbines and two fixed-blade propeller turbines. It is customary to run the latter at their optimum efficiency and take up any variation in flow on the Kaplan machines. The barrage allows of sufficient storage for a day's operation under unfavourable flow conditions, the station generally ceasing to operate during the night. The barrage consists of six sluices, each of 15m span, closed by Stoney sluice gates, there being two gates in each sluice. The topmost gate is the smaller of the two with a height of 4·4m (the total height of the two gates is 13·65m) and for small regulation of the flow this gate is lowered down behind the larger one. For larger regulations the two gates are then lifted together. The lifting gear is situated in a covered gangway built right across the barrage.

LA VANELLE

The lay-out of the La Vanelle project is that of a typical low-head installation, as may be seen from the plan Fig. 2, and the cross sections of the power station and barrage, Fig. 3. There are three 11MW Kaplan turbines in the power station, each connected to an umbrella type alternator which generates at 5·7kV. The annual production of the scheme is about 150 million kWh. Most of the recent French hydro-electric projects are noteworthy for the high standard of their architecture, and La Vanelle is one of the best of them. Its pleasing aspect may be noted from the illustrations Figs. 5 and 6 on the opposite page, which show the completed project. The exterior concrete surface of the power station has been painted in white and cream with a petrifying paint.

The four sector gates of the barrage are similar in design to the gates of the barrage at Donzere, on the River Rhone, as may be observed from Fig. 3.§ Each gate is of 18m span and is fitted with a "shutter" hinged to the top of it, for control of small variations of the reservoir level. An interesting point about the gates is that the shutters can be raised or lowered over a range of 2m, thus providing a larger range of adjustment than in previous gates of this kind. A number of projecting nibs are fitted to the shutter, so that air is entrained in the sheet of water overflowing, and undesirable vibrations are avoided. For the larger discharges which the 2m depth of shutter adjustment allows however (maximum discharge 100 cubic metres per second) these nibs are not effective, and the entrainment then takes place only at each side of the gate, which is fitted with deflectors to direct each edge of the over-flowing sheet towards the centre of the gate, so that the discharge falls clear of the gate mechanism. With the gates raised a flow of 3550 cubic metres per second can be passed at the normal reservoir level of 136·25. For maintenance, stoplogs can be placed upstream and downstream of each gate; they are placed in position by a transporter (see Fig. 2), which is built in two parts, the lower part travelling along the service road across the barrage to the appropriate span, where the upper part travels out along the rails on the roofs of two adjacent winch houses to emplace the upstream stoplogs.

La Vanelle is similar in many respects to the Seyssel project on the River Rhone.‖ The power of the machines is less (13,000 h.p. as against 20,000 h.p.) and they are smaller in size, the diameters of the runners of the turbines at La Vanelle and Seyssel being respectively 5m and 6·3m (distances centre to centre of turbines 17·5m and 23·5m, maximum heads 8·75m and 9·5m, and flow through each machine at rated power 145 cubic metres per second and 220 cubic metres per second respectively), the normal speed of the machines at La Vanelle being 100 r.p.m. as against 75 r.p.m. at Seyssel. It is of interest to note that sluice gates have been constructed to close each of the two sluices of each turbine at La Vanelle, and the novel method of employing stoplogs described in our article on the Seyssel project has not been adopted in this case. A steel-framed construction has been used for the power station, and in several instances steel construction was used in preference to concrete to save construction time.

§ See THE ENGINEER of December 22, 1950.
‖ See THE ENGINEER, December 15, 1950.

CONSTRUCTION

Constructional work generally was hindered by shortages of materials and other difficulties of the post-war period. Various methods of construction were studied extensively with hydraulic models; the heavy floods which occur on the Isere, combined with the fact that the bed rock, although adequate as regards compressive strength and impermeability, was particularly vulnerable to scour, were factors which made this study important, if not critical. Originally it was intended to build the power station first, and then to construct the piers of the barrage with compressed air caissons, and then to enclose one bay of the barrage at a time with steel sheet piled cofferdams for construction of the sill and invert. This method, however, would have produced excessive scouring, in the event of flood, in the bays which were left free.

The method eventually adopted consisted of dividing the work into four stages as explained below. First, the site of the power station was enclosed by steel sheet piles, as shown in Fig. 2, and dewatered. The power station was then constructed up to the "Stage 1" level indicated in Fig. 3, the long pier between the power station and the barrage, and the tailrace being built in this stage. When Stage 1 was complete, the cofferdam was removed and the river allowed to flow over the substructure of the power station. Lines of steel sheet piling were then driven from the right bank to the centre pier, as also shown in Fig. 2, and the site of the barrage was dewatered. The foundations of the barrage and the lower parts of the piers were then built. The concrete of the sill was given an admixture of powdered iron to increase its resistance to scour, a method employed with success in the mortar bonding the masonry at the Pizançon barrage. Scour protection also included the placing of tetrahedrons of concrete upstream and downstream of the barrage structure.

When Stage 2 was complete and the cofferdam removed, piles were again driven to enclose the power station and the head race (see Fig. 2), which were then completed up to the main floor level. The fourth stage consisted of completing the building work of the power station and piers of the barrage, and fitting the sluice gates. The gates were installed in the "up" position and then lowered on to the sill which had been built in the second stage. The constructional method was severely tested by sharp floods of 1750 cubic metres per second and 1790 cubic metres per second (ten yearly flood: 1500 cubic metres per second) occurring in June and September of 1948, and causing the flooding of the second stage on each occasion, which thus took eight months to complete instead of six as envisaged. No damage was done, however, to the permanent works already completed.

Aggregates for concrete making were

THE ABBEY WORKS OF THE STEEL COMPANY OF WALES

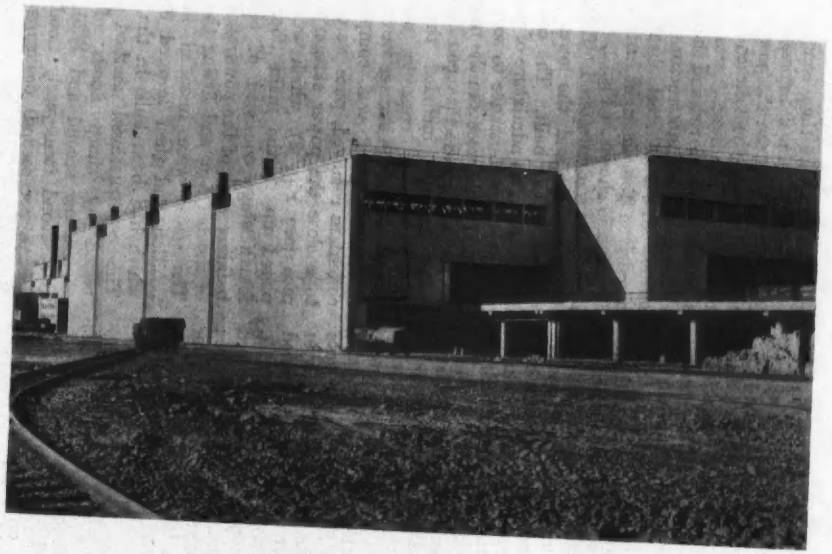


FIG. 14—ENTRANCE TO RAW MATERIALS BAY

FIG. 15—MOULD PREPARATION BAY

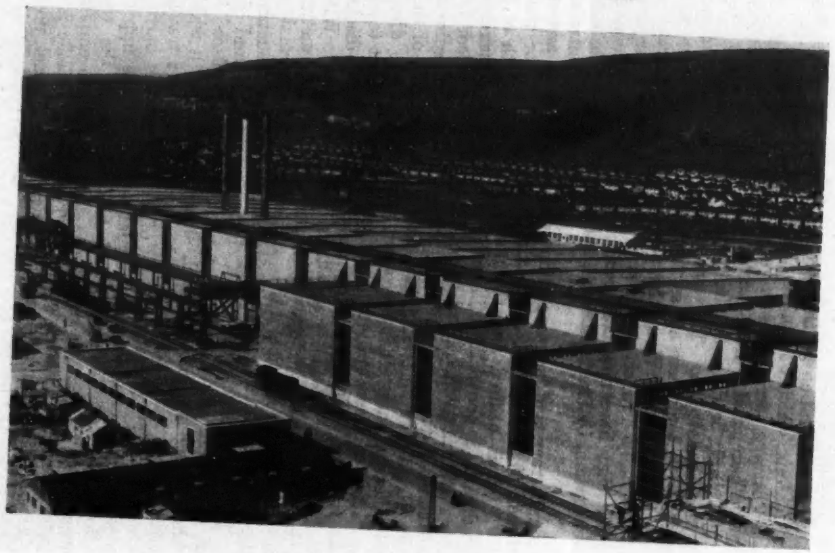


FIG. 16—MAIN MILL BUILDING

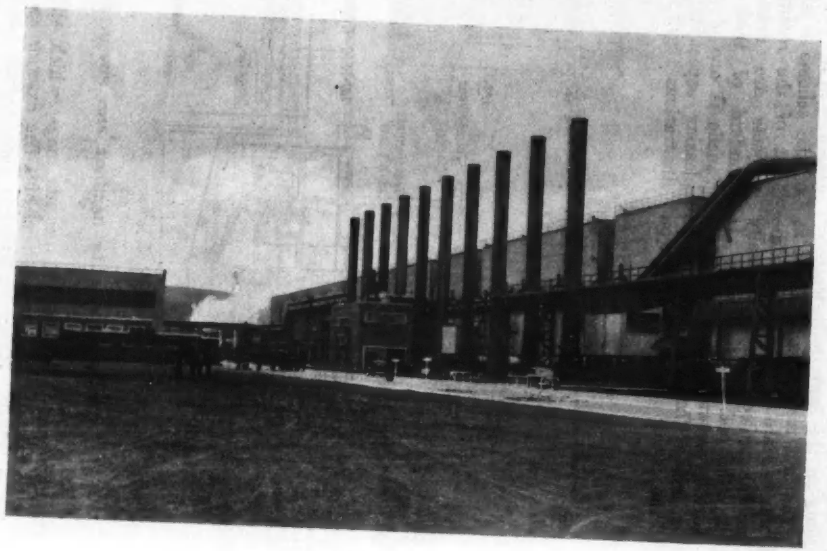


FIG. 17—SOAKING PITS BUILDING

obtained from a nearby quarry, a crushing, washing and screening plant with a capacity of 25 cubic metres per hour being built on the site. The first stage of this plant consisted of a rotating perforated drum, through which the aggregates passed for preliminary cleaning to remove a calcareous film present on each of the stones. There was then a primary jaw crusher, secondary gyratory crushers, and the various washing and screening installations leading to storage hoppers. The concrete was volume-batched, mass concrete having five grades of aggregate (maximum size 80mm) and finer concrete four grades (maximum size 40mm), and was largely placed by concrete pump.

(To be continued)

The Works of the Steel Company of Wales

No. IV—*(Continued from page 621, November 16th)*

AT the new Abbey works, which cover an area of some 550 acres, the principal production departments have been set out in four large buildings. It will be seen from photographs of some of the buildings, which are reproduced on page 648, that a departure has been made from the conventional style of steel works and mill structure. The steel sheet covering the steel framework of the buildings is treated on the inside with aluminium paint, which brightens the general appearance, and the straight lines are broken by large areas of glazing curving inwards towards the top.

The first of the buildings in the production sequence is the melting shop which incorporates a raw materials and scrap box filling bay, a charge-holding bay, a furnace bay and a casting bay. It is 1870ft long, 397ft wide and has a maximum height of about 89ft over the furnace and casting sections and 69ft over the raw materials, scrap filling and charge-holding bays. A view of this shop from one corner is reproduced at the foot of this page and a photograph from the far corner showing the entrance to the raw material bay is reproduced in Fig. 14, on page 648.

A mould preparation and general stores building, 880ft long by 107ft wide, shown in Fig. 15, is laid down between the top ends of the melting shop and the main mill building. This mill building, see Fig. 16, has one 68ft high bay, 4008ft long by 100ft wide, in which are arranged in the following order the ingot stripper section, soaking pits, mill and plate-finishing section. Adjacent to the mill and under the same roof are a 54ft high slab furnace bay and two covered slab yards. Two 1400ft long bays at the side of the plate-finishing section are laid down for sheared and coiled sheet processing.

A cold mill is laid down as a self-contained unit in a separate five-bay building adjacent to the processing end of the main mill. In this building the centrally disposed mill bay, about 1000ft long, is flanked on one side by an annealing and a pickling bay and on the other by processing and inspection and dispatch bays.

For the foundation construction of the melting shop and the main mill buildings the contractors were George Wimpey and Co., Ltd., and for the cold mill John Laing and Son, Ltd., and the work was carried out under the supervision of W. S. Atkins and Partners, consulting civil engineers, the co-ordinating consultants being the International Construction Company, Ltd.

Although, as already stated, we do not propose to deal in these articles with the constructional side of the project, some notes on the main structural steelwork carried out by Dorman Long and Co., Ltd., should be included as of general interest to engineers. That company was responsible for more than 26,000 tons of the structural steelwork involved, the central part of which was the melting shop building, embodying 18,000 tons of welded constructional steelwork, the cold mill buildings, also of welded construction, requiring 6500 tons. A further 1500 tons of steelwork was used in the construction of the mould preparation shop.

The heavy character of the melting shop structure necessitated the adoption of new techniques of fabrication and it was not possible to prefabricate at the Middlesbrough works of the company the heavy crane girders, some of which weighed 90 tons and are 110ft long and 12ft 6in deep. To facilitate the construction of the melting shop the first work undertaken was the building of the mould preparation shop. On completion this shop was converted into a fully equipped modern fabricating shop, in which the heavy members required for the steel plant buildings could be fabricated on site.

The equipment developed for the work included two large manipulators, inside which the heavy crane girders were fabricated by welding. These manipulators enabled the assembled parts to be rotated so that all welding could be carried out in a downhand position. They were equipped with a roller track for the completed girders to be withdrawn by winches on to specially prepared bogies, on which they were transferred to the adjoining site of the melting shop. A 100 tons capacity Goliath crane was designed and built for erecting the heavy stanchions and the crane girders which rested on them. This girder bridge crane was supported on steel trestles with bogies travelling on railway tracks in the normal manner. A lifting crab moved crosswise along the lattice bridge and the entire crane was able to move longitudinally down the building as work proceeded. When the 90-ton crane girders, which were installed, arrived under the Goliath crane, they were picked up in a specially designed cradle and lifted into position on the stanchions.

The roof steelwork and the lighter construction work was erected by the use of a crane travelling along the crane gantries after their erection. The steelwork of the roof, which was of the high/low construction, was coated with aluminium by the metallisation process in the anticipation that it would reduce the corrosion always experienced in such buildings.

The Melting Shop

The raw materials for the furnaces—mostly steel scrap—are taken into the melting shop in railway wagons, which are pushed up an inclined ramp, to be seen in Fig. 14. The scrap is unloaded directly into boxes ready for furnace charging. Trains of ladle cars bringing molten iron from the Margam blast furnaces are run into the mixer bay at the opposite end of the building. Here the ladles are lifted off their carriages by a 135-ton crane and their contents emptied into one of the two 800-ton inactive hot metal mixers. These mixers were supplied by the McKee Division of Head Wrightson and Co., Ltd., and can be fired either by blast furnace gas or oil-fuel. In

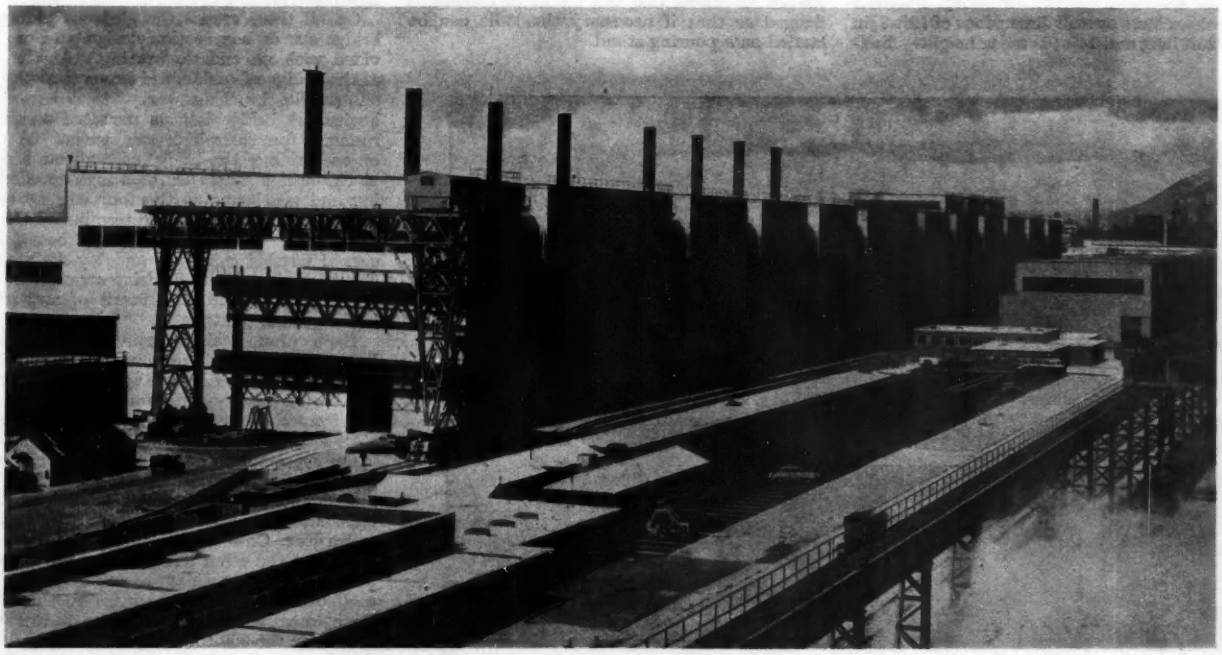


FIG. 18—MELTING SHOP

them the metal is kept at a specified temperature until it is required for charging the open hearth furnaces. Hot metal from the mixers is transferred in 75-ton ladles by an electric locomotive to a point opposite the furnace to be charged. Then, by means of a pouring trough, the contents of the ladles are emptied into the furnace by a 135 tons capacity crane. Scrap is charged into the furnace by a 10-ton Arrol Morgan non-rotating charging machine.

In the photograph reproduced in Fig. 19, the charge-holding bay can be seen with a mixer in the background and the charging machine emptying boxes of scrap into a furnace in the foreground.

At present eight of the twelve 200-ton, oil-fired basic open hearth furnaces have been installed and of these five are already in operation. These furnaces have been built to the designs of the Open Hearth Combustion Company of America and drawings prepared by this company were converted to British standards by John Miles and Partners (London), Ltd.

The joint contractors for the installation of the furnaces, Priest Furnaces, Ltd., Middlesbrough, and G. P. Wincott, Ltd., Sheffield, were responsible for ordering and co-ordinating the supply of all refractory materials, structural steelwork and castings for the eight furnaces, and they provided all labour for erection under the general supervision of the consulting engineers. The furnaces are arranged at centres of 110ft in batteries of four, and a 55ft clearance between each battery provides storage space for hot metal chutes, fettling machines, &c.

Each furnace, with its external flues, reversing valves, waste-heat boiler and chimney, occupies a ground space approximately 103ft wide by 150ft long. This length is the overall distance from the front of the slag chamber bindings to the extreme face of the chimney base. The ground space occupied by each complete furnace is therefore equivalent to 77·25 square feet per ton of capacity.

Each furnace bath is 51ft 8in long between knuckles, the width at the foreplate level being 16ft and the roof 8ft high above the foreplate level. At the knuckle the throat is 10ft 9in wide at foreplate level and 13ft 9in at the roof, the height being 8ft. The air uptakes have a combined area of 96 square feet at each end. Five charging doors are set at 9ft 1½in centres. A slag chamber at each end is 18ft 6in wide at the arch springing and 24ft long at the paving course. Four regenerator chambers are arranged in pairs and operate in tandem, their internal dimensions being 13ft 4in wide at the arch springing, 27ft long and 24ft 4in high to the arch soffit. Danforth-Petersen air checkers have overall dimensions of 12ft 8½in wide, 26ft long and 14ft 9in mean height. Self-supporting steel chimneys 150ft high have an internal base diameter of 7ft.

Water-cooled charging doors and frames for the furnaces were supplied by Blaw Knox, Ltd., which company also made the air reversing equipment, including water-cooled dampers and frames, hoods, fans and air mains.

The furnaces are tapped into 200-ton ladles in the casting bay, illustrated in Fig. 20. These ladles are believed to be among the largest of their kind in the world and two can be seen in the illustration under a refractory lining drying unit. The ladles were supplied by Head Wrightson and Co., Ltd., and each has a net weight of 48 tons without the hot metal and refractories. The ladles have an inside diameter of 13ft 5in at the top and 11ft 7in at the bottom, with an overall height of 14ft 4in. They are mounted on trunnions 1ft 6in diameter, set at 15ft 6in, and each of the two trunnions of a ladle weighs 7 tons 7 cwt.

The 1¼in thick side-wall plates of a ladle are butt welded and the 2in thick disced bottom plate is riveted by a double row of 1¼in rivets to the side walls. To prevent distortion, three 2in thick butt straps are riveted to the side-wall plates. Normally a ladle is teemed from the crane hooks but the trunnion casting is flanged so that if necessary the ladle can be landed on a pouring stand.

When it has been filled a ladle is carried from the tapping stand by one of three 300-ton cranes, which serve the full length of the bay, and traverse to an ingot mould pouring line on the opposite side of the bay. On this line moulds on a train of cars are filled in turn as the crane carries the ladle along its length. Trains of cars carrying the filled moulds are hauled out of the building and taken via the rail system to the stripper bay in the main building.

The heavy handling equipment in the melting shop—three 300-ton ladle cranes, two 135-ton cranes in the charge-holding bay and the 135-ton crane in the mixer bay were all supplied by the Adamson Alliance Company, Ltd.

The 300-ton ladle cranes run on a span of 69ft 6in. They are of eight-motor, four-girder design, having an auxiliary trolley with two lifts of 60 and 20 tons capacity. The load is carried on fifty-two falls of rope reeved on two barrels, each 5ft 6in diameter. The 135-ton holding and mixer bay cranes have interchangeable trolleys and each is fitted with an auxiliary trolley with a single lift of 40 tons capacity. On these cranes the main load, 135 tons, is carried on twenty-eight falls of rope, the barrels being similar in design and size to those on the 300-ton cranes.

On all these cranes the girders forming the bridge are of box section design and are provided with an end tie bracing. At the ends of the bridge of each crane two cast steel yokes on saddle brackets carry two two-runner bogies. A bridge is thus mounted on sixteen runners, four of which are driven. A drive on each side of the bridge comes from a motor at the bridge centre through high-speed shafting and gearboxes at the four corners of the bridge. Final drive is then terminated through the slow-speed shaft of the gearboxes, half-geared flexible couplings and lay-shafts on to the drive axle. By this drive arrangement the bogie can oscillate as a result of any irregularities of the gantry.

Each crane cab is completely insulated, being fitted with double armoured plate-glass windows, lined with fibre glass wool and supplied with an air-conditioning unit. The trolley frames are built up of heavy structural steel sections with the main beams welded.

On the main trolley the two-motor, double-gear interlocked drum hoist has each of the intermeshing drums mating with pinions carried on shafts at one end of which is mounted a worm gear. One of these worm gears is cut right-hand and the other left-hand, and they are so placed that the meshing worms are in line with each other and at right-angles to the drums. Each worm is directly connected to a 200 h.p. motor (on the 300-ton cranes) through a flexible coupling, and the two worms are directly connected to each other by a shaft and

FIG. 20—MELTING SHOP CASTING BAY

FIG. 19—MELTING SHOP STAGE

geared flexible couplings. This arrangement gives simple and accurate adjustment between the two lines of gearing, so that although the drum gears are intermeshing there is not actual contact between the teeth in the normal operation of the crane. It forms a safety measure, which comes into operation in the case of a mechanical failure.

The two hoist motors are synchronised to share inequalities of load in the case of poor brake adjustment and, in addition to an Igranic electric brake, an emergency brake is fitted on each hoist motor drive. The cranes are fitted with a rope safety measure, which allows any one rope to break or two diagonal opposite ropes to break without materially altering the position of the ladle beams.

The Main Mill

In the ingot stripping shop of the main mill the moulds are removed from the cars and stripped by one of two 200 tons capacity stripping cranes, supplied by the Adamson Alliance Company, Ltd. These cranes, to be seen in the illustration of the bay in Fig. 21, are designed to lift an ingot and mould with a combined weight of 40 tons. They have a span of 92ft and are similar in design to the ladle cranes already described, except that their bridges are supported on eight runners only, four of which are driven. A combined screw stripping and extractor mechanism is fitted to these machines.

When the machines are used for stripping conventional moulds the stripping ram is extended down to contact the ingot. The screws are so designed that, when extracting "big end up" ingots from their moulds by retracting the stripping ram the extractor gear is brought into operation for heavy serrated bits to grip the ingot and extract it from the mould. Hydraulically operated stripper tongs or holding-down arms are fitted.

After stripping, the ingots are taken to an adjoining storage and inspection area, whence they pass on for charging into the soaking pits shown in Fig. 22. The ingots are generally up to 66in by 33in by 70in and weigh up to 19 tons.

The soaking pit charging machines, also made by Adamson Alliance Company, Ltd., have trolleys fitted with a guide frame in which vertical moving columns have at their lower ends motor-operated tongs for gripping the ingots. These machines are of 20 tons capacity and their tongs incorporate an arrangement for intensifying their grip on an ingot so that they close with more than double the pressure imparted mechanically. Under this arrangement, when the tension on the ropes supporting the vertical moving columns is relieved, the weight of the columns is placed on slide blocks to impart an additional closing load on the tongs.

Twenty bottom-fired soaking pits and their auxiliary equipment have been installed by the Wellman Smith Owen Engineering Corporation, Ltd. Each of these pits is 15ft by 16ft by 11ft deep and is designed to hold a charge of 100 tons. They are arranged in double rows each of ten pits.

In the pits the ingots are arranged in a single row along the walls and are equi-distant from the single firing port in the bottom of the pit, and in this way they surround a flame which gives complete combustion without impinging upon their surfaces. The gaseous products from the flame travel between the ingots and exhaust through ports at hearth level.

In an air recuperator at each end of a pit, the waste gases travel vertically downwards through thin-walled, octagonal-shaped refractory tubes and are then taken to a chimney in refractory lined steel chimneys. One self-supporting chimney, 100ft high by 5ft diameter inside the lining, exhausts the gases from each pair of pits. The air to be preheated for combustion is blown by a motor-driven fan having a duty of 360,000 cubic feet per hour at 7in W.G. The air enters the recuperator chamber from a distribution pipe connecting two inlet blocks built into the side wall of the recuperator and flows directly into the air passes. The air flows around the refractory tubes through an ascending shuttle path formed by a series of horizontal baffle tiles to the top of the recuperator, where it enters a collecting flue which leads direct to the burner.

The side walls of the pits are slightly radiused to increase stability and both the pits and the recuperators are adequately insulated. A layer of coke breeze 18in thick is placed on each pit bottom, which has, in addition to the firing port, four clean-out holes through which the slag and scale is removed by means of a special shaped scraper which is attached to the ingot crane.

Fig. 22—Soaking Pits

Each pit is provided with a flat suspended cover of refractory material which has a rigidly braced steel supporting frame with dipper castings of heat-resisting material arranged to fit into a deep sand-filled seal. This cover when in position provides a positive seal to eliminate air infiltration and to ensure that the pit is maintained at a constant pressure. Four fixed pads are attached to the top of the pit binders on which the cover rests.

Two Wellman cover carriage machines running on rails at 44ft centres are arranged to lift a cover and travel with it in either direction. The hoisting and travelling movements of these machines are interlocked to prevent dual operation. Each member has a hoisting speed of 5½ft per minute and a travelling speed of 129ft per minute. When a pit cover is lifted either to charge or to discharge an ingot, the fuel, air and chimney draught valves are automatically and almost instantaneously closed, and when the cover is lowered into position the valves are reopened. This automatic valve closing and opening, in addition to saving fuel, protects the crane operator and makes for speedier location and handling of ingots.

The pits are fired by a mixture of blast-furnace and coke-oven gas having a calorific value of 135 B.Th.U. per cubic foot. A central gas mixing station is completely equipped with flow units, pressure regulators, meters, temperature and pressure recorders, and two gas boosters to give a pressure of mixed gas at the pit burner of 27in W.G.

In addition to the automatic cut-off of fuel, air and draught, at the opening of the cover, complete automatic control equipment comprising temperature control, combustion control, and pit pressure control is included. A special

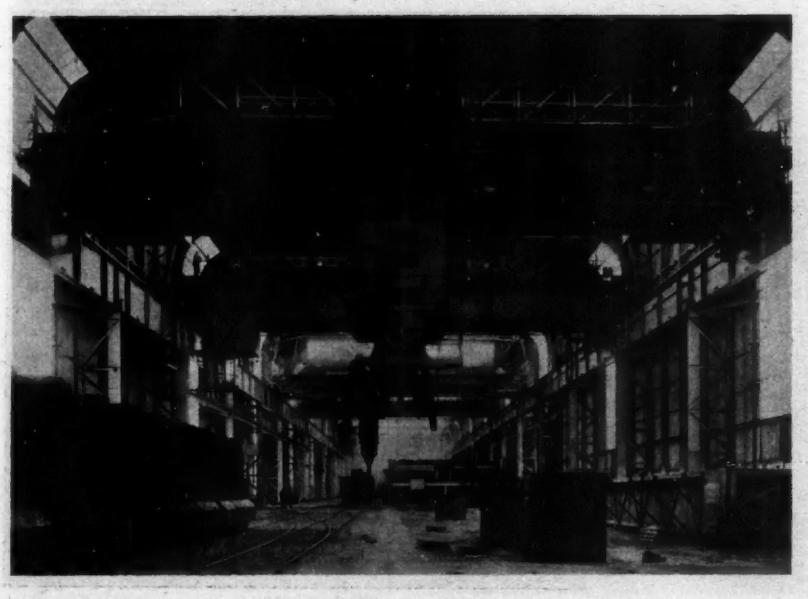


Fig. 21—Ingot Stripping Shop

panel is provided for each set of pit control instruments used. The instruments for each two adjacent pits are housed in a steel-framed cabin suitably glazed and ventilated.

Coke and cinder handling equipment for the pits, comprising two coke hoppers and two buckets with an electrically operated transfer car are installed for conveying coke breeze from the main hopper at the end of the shop to the soaking pits. Cinder from the bottom of the pits is discharged into tipping cinder buckets fitted with self-locking lifting brackets carried upon trunnions. They are supported upon feet at each side to allow the removal truck platform to be placed under the bucket for lifting and transport. A battery-operated truck transports the cinder buckets to the cinder handling building.

(To be continued)

1000kW Marine Gas Turbine Set

No. II—*(Continued from page 614, November 16th)*

Compressor Turbine

THE compressor turbine is an axial-flow unit consisting of two stages.

The two "G. 18 B" steel rotor wheels and the stub shafts are bolted together by means of a prestressed manganese-molybdenum bolt passing through the centrally bored wheels and specially designed to withstand the high expansion which occurs in the wheels themselves. "Hirth" couplings are again utilised to locate the wheels and the Nitralloy steel stub shaft. One of our drawings illustrates this coupling. The shaft is hardened on the bearing journals.

The rotor blades were manufactured by the Plunge Grinding process, patented by the Bristol Aeroplane Company, and are of Nimonic 80.A, secured in axial "fir tree" serrations in the periphery of the wheels, each blade being fixed by a locking key. All stator blades are of Nimonic 80 material made by the lost wax process of precision casting. The casing consists of an inner and centre centri-spun cast stainless steel (B.S. En. 58C) member, supplied by Firth Brown and designed to allow all parts to expand freely and yet remain concentric. In the drawing reproduced below are several details of this construction showing the manner by which the casing rings, rotor blade shroud segments and stator blading are located and secured. The inner cast ring is itself secured from the joint of the compressor turbine and power turbine external casings. Housed concentrically within that casting is the centre ring, which is located therein by means of radial keys in such a manner that it is free to expand in a radial direction at all points on its circumference. Bolts, each mounting a squared key, lightly secure the members circumferentially on their jointing faces, whilst the key pieces fit with corresponding radially elongated parallel slots in the centre casing ring.

The first-stage stators are riveted in groups to segmental strips to form assemblies easy to handle. Each second-stage blade is secured in a groove in the centre casing ring and positioned circumferentially by means of two pegs. The inner end of the blades has a cylindrical projection which fits into a radial hole in the diaphragm. This engagement is such that the stator blade is free to expand radially towards the centre of the diaphragm and the diaphragm to expand radially outwards.

The diaphragm is protected by heat shields designed to prevent distortion due to the temperature gradient. One of our illustrations shows a view upon the second-stage rotor looking upstream and taken after initial running tests.

Inner segmented shroud rings of H.R. Crown Max. steel are arranged to expand circumferentially in grooves in this centre ring, each segment being also located circumferentially by a peg. This arrangement maintains the blade tip clearances at all loads, thus improving the efficiency and also making it quite safe to shut down and start up quickly. Cooling air from the compressor passes around the inner casing and through passages in the centre casing ring before joining the main gas stream.

In the drawing below the cooling air passages in that member are shown. They are closely spaced and each bears a helically twisted strip within the hole to improve the heat transfer.

Great attention has been paid to the efficient cooling of the rotors and casing. There are other cooling systems so arranged that air from the compressor delivery passes through passages in the turbine casings and up both sides of the turbine rotor discs, finally joining the main gas stream.

As the coupled compressor and driving turbine shafts are supported in three bearings, allowance for any misalignment of the shafts is made by connecting them by means of a quill shaft forming an extension of the turbine shaft, which is located in the bore of the compressor shaft. The driving torque is, however, transmitted through a normal gear-tooth muff coupling. The compressor turbine exactly achieved the design efficiency of 85 per cent (total head to total head) at the designed point and exceeded this figure by 1 per cent at lower duties.

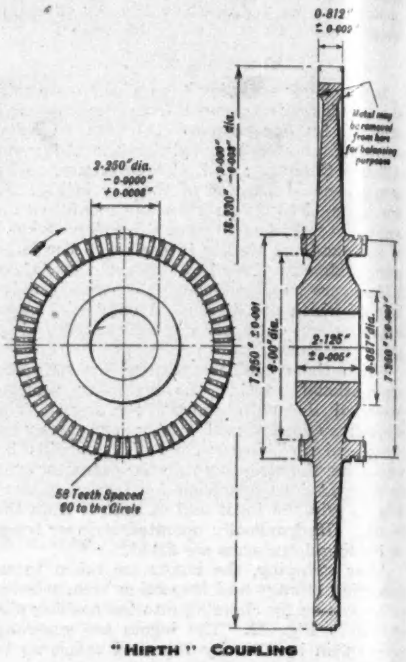
Power Turbine

The axial-flow power turbine consists of a single-stage, mechanically independent of the compressor turbine.

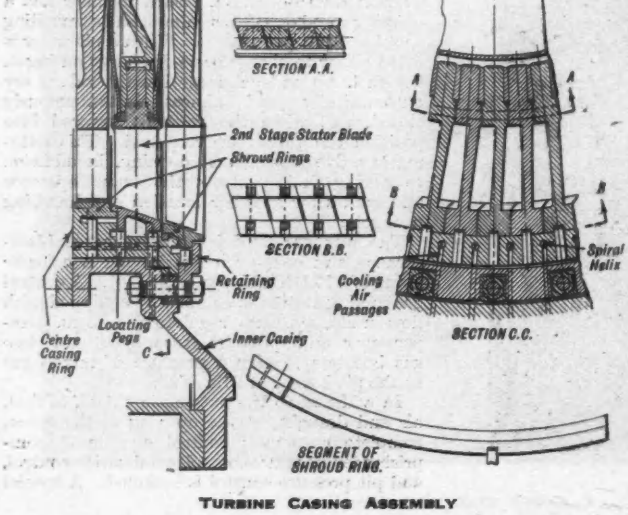
The materials and general construction of the turbine are similar to those already described for the compressor turbine, with the exception that the rotor wheel is of Jessop's "H.40" Ferritic steel. The designed turbine efficiency is 84 per cent and its speed 6750 r.p.m.

The bearing is connected radially to the outer main turbine casing by four radial fabricated struts passing through streamline airfoils, which are themselves integral with the mild steel turbine exhaust diffuser ducting assembly.

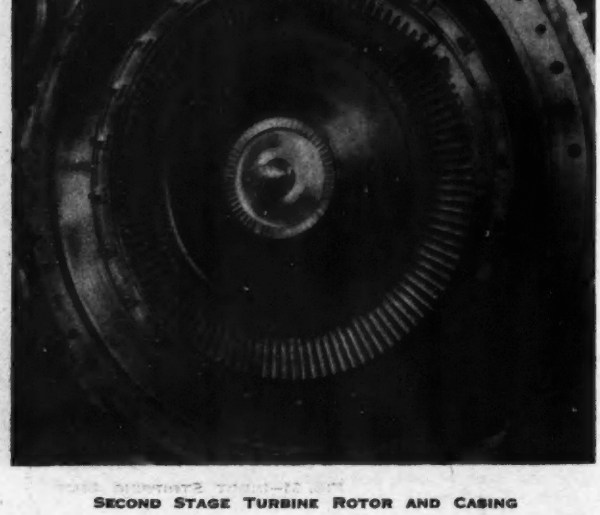
On the turbine end of the shaft is a double.



"HIRTH" COUPLING



TURBINE CASING ASSEMBLY

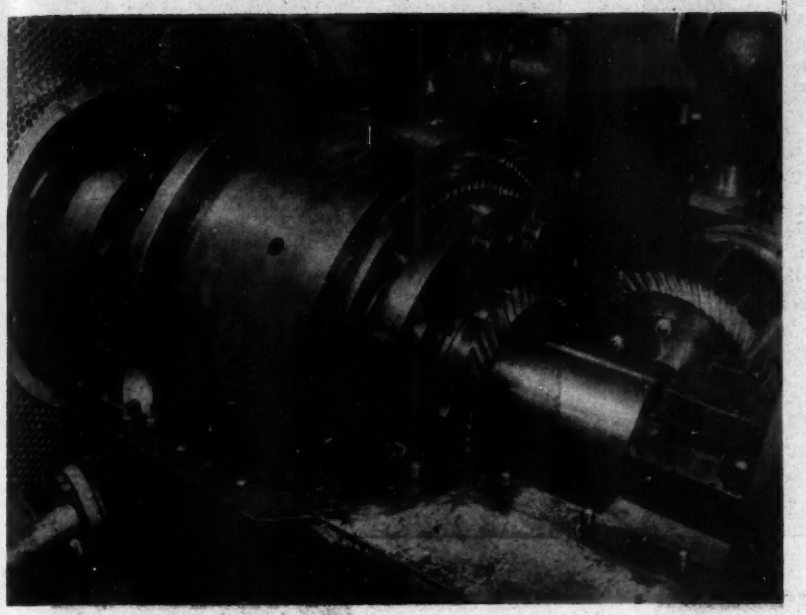


SECOND STAGE TURBINE ROTOR AND CASING

stage labyrinth gland which is carried from the adjacent bearing housing, cooling air being directed between them. This turbine shaft carries on the other side of the wheel end bearing the opposed unbalanced rings of the emergency trip governor. The turbine shaft connects through an internal tooth coupling with the tunnel shaft.

Flywheel and Gearing

To assist the speed governor during sudden load changes, a small flywheel is fitted on the high-speed shaft and housed in the reduction gear casing. It is located through "Hirth" couplings to the stub shafts which connect on one side with the tunnel shaft by an internal tooth coupling. The other stub shaft is housed in a thrust bearing and drives the floating sun wheel of the epicyclic unit through a flexible coupling of the double helical tooth type.



Double Helical Epicyclic Gear

Speed reduction between power turbine and alternator is achieved by a double helical Allen-Stoeckicht epicyclic gear, which offers the maximum saving in weight and space. The gear is designed on the Stoeckicht principle by which is ensured equal load sharing, not only between the planet wheels, but also between the helices, and it is capable of transmitting 1800 h.p. continuously from a turbine speed of 6750 r.p.m. to an alternator speed of 1500 r.p.m. There are no high-speed shaft bearings in the gear unit, the sun wheel being supported between the three planet wheels and connected to the power turbine by means of the flexible coupling.

The two internal gear annuli are located through internal and external toothed coupling rings to a coupling flange in the gear cover. The planet carrier is rigidly connected to the alternator.

Reproduced herewith is an illustration of the gear unit with the top cover removed, and showing the bevel gear drive to the governor and tachometer. Another illustration shows the arrangement of flywheel, gearcase, alternator, speed governor and tachometer, and the lubricating oil filters mounted at the side of the alternator.

Alternator

The Allen alternator is an open, self-ventilated, rotating-field, salient-pole machine with a continuous maximum rating of 1000kW at 0·8 power factor, 50 cycles per second, at a pressure of 400/430V, three-phase, when driven at 1500 r.p.m. It has an overload capacity of 20 per cent for a period of ten minutes.

The stator windings are insulated with moulded micanite, and held in position by synthetic-resin-bonded fabric wedges. The rotor shaft is carried in a single split-sleeve, pedestal bearing and is arranged for rigid coupling to the gear wheel shaft. The bearing is pressure lubricated, oil being provided from the turbine lubrication system.

The exciter is a two-bearing machine, flexibly coupled to the rotor shaft, and is provided with a carbon-pile voltage regulator in the shunt field circuit, and, to obtain quick voltage response, a permanent-magnet pilot exciter is employed, belt driven from the main exciter. The use of a permanent-magnet pilot exciter avoids the necessity for a small commutator and brush gear. It comprises a four-pole permanent-magnet rotor in a normal stator frame, the output from which supplies the field of the main exciter through a metal oxide rectifier mounted in the air stream of the main exciter at the bottom of the commutator end bracket.

Speed Control Governor

The governor is a centrifugal unit driven from the power turbine shaft and operates the fuel throttle valve through an oil relay. This relay is supplied with high-pressure oil and is arranged so that in the event of a failure of the lubricating oil supply the machine is automatically shut down.

The speed governor is provided with a manual speed-regulating handwheel positioned on the governor itself, capable of adjusting the speed of the power turbine at no-load within 5 per cent above or below the rated speed. A small electric motor is also embodied in the governor gear, enabling this speed adjustment to be effected from both the switchboard and the control panel.

General

Mounting.—The unit has no base plate, a three-point mounting being effected by securing the compressor independently, and it is anchored on resilient mountings. The other supports consist of manganese-molybdenum posts resiliently mounted on each side of the heat exchanger and their deflection takes care of thermal expansion. One resilient mounting is shown sectioned in the inset drawing of last week's issue and consists of top and bottom rubber pads holed to receive the bolt and its concentric rubber and steel sleeves.

Bearings.—All the main compressor and turbine bearings accord in design with well-established steam turbine practice. The bearings are of steel, lined with white metal, with the exception of those which may be subjected to higher temperatures, which are lined with lead bronze. They are lubricated and cooled by oil at a pressure of approximately 10 lb per square inch. Ball and roller bearings are incorporated in the auxiliary drives. The journal bearings are fitted with thermo-couples and hydraulic wear gauges are incorporated with the Michell thrust bearings, and are supplied from the high pressure oil system.

Labyrinth Glands.—The casing glands of the compressor and turbine, as well as the inter-stage glands, consist of stationary stainless iron fins, working in conjunction with stepped shaft journals.

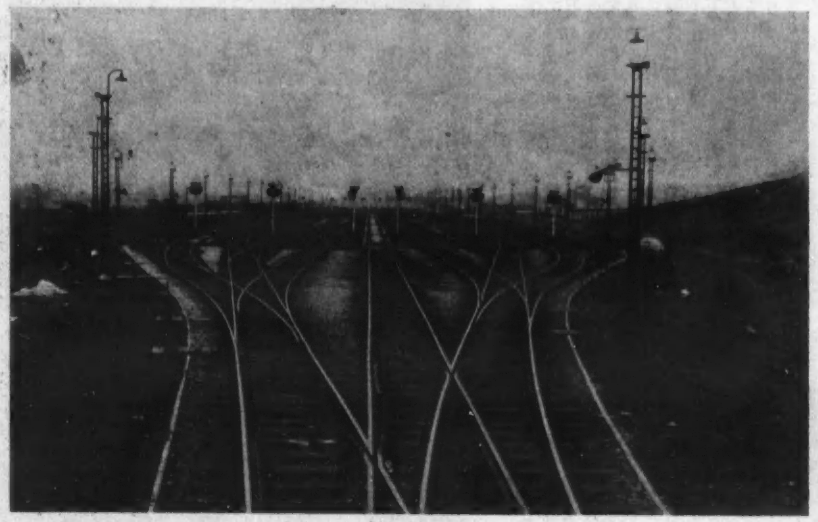
Flexible Couplings.—The turbines and their driving shafts are coupled by means of continuously-lubricated internal tooth couplings, oil being fed by centrifugal force through internal passages to each tooth engagement.

Lubrication System.—The lubricating oil system closely follows usual steam turbine practice, embodying two separate valveless gear-type oil pumps. One pump delivers oil at approximately 120 lb per square inch gauge to the governor oil system, whilst the other delivers oil at approximately 45 lb per square inch gauge for bearing and gear-teeth lubrication.

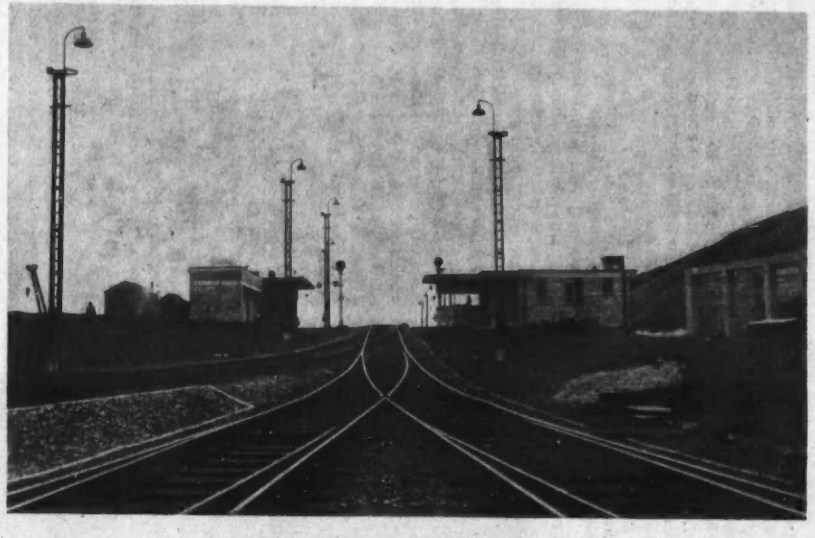
The pumps are arranged for driving in tandem either by an electric motor when starting

Arrangement of Flywheel Gear Unit and Alternator

MODERNISATION OF TOTON "UP" MARSHALLING YARD



ARRIVAL SIDINGS FROM THE HUMP



HUMP FROM THE SORTING SIDINGS

SORTING SIDINGS FROM THE HUMP

CONTROL TOWER OPERATING ROOM

up or by the turbine shaft through gearing during normal running. A clutch arrangement is provided, which enables the drive to be automatically transferred from the motor to the turbine when the latter has reached a speed sufficient to maintain the pressure in the oil system.

The oil for the governor pump is taken from the lubricating system so that the oil for both systems passes through a filter and cooler.

Starting Procedure

The starting procedure is briefly as follows :—

The compressor is run up by an electric motor to approximately 1500 r.p.m. (taking approximately 16 h.p.). The torch igniters are then lighted by means of an ordinary sparking plug and when the thermo-couples indicate that they are operating satisfactorily the main fuel supply is switched on to the burners. Further thermo-couples indicate when each combustion chamber is alight and upon verification that all chambers are functioning satisfactorily, the turbine is accelerated on the hand throttle valve. The starter motor continues to assist the turbine up to a speed of approximately 2500 r.p.m., when the turbine becomes self-sustaining and its speed overtakes the starter motor, which disengages by means of a free-wheel clutch. As the turbine speed approaches no-load speed the automatic speed control governor takes over control of the fuel supply through the oil-operated throttle valve. The time required to reach the no-load condition is approximately one minute. Normally the turbine is run for five minutes at this condition for warming up before proceeding to higher loads but, if necessary, it is capable of accepting full load straight away, giving a time for obtaining full load of approximately 1¼ minutes.

No barring-over of the machine is necessary after shutting down, but oil circulation to the bearings is continued for a few minutes.

Testing

The adiabatic efficiencies quoted for the compressor and its turbines were obtained by the Bristol Aeroplane Company, which has carried out tests on these members as separate, independent units. Pressure combustion tests carried out on the combustion chambers at the normal working pressure by Joseph Lucas, Ltd., proved the combustion efficiency to be slightly in excess of 98 per cent.

Aerodynamic tests were undertaken by Messrs. Allen at their Bedford works on scale models of the compressor inlet and outlet ducting, the heat exchanger return header and the power turbine exhaust diffuser, to reduce the flow-path losses to a minimum.

Methods of securing the heat exchanger tubes were the subject of a number of experiments at Bedford, resulting in the use of expanded ferrules, as already described.

Modernisation of Toton "Up" Marshalling Yard

THE Toton marshalling yard on the London Midland Region of British Railways is a key point in the distribution of coal from the Nottinghamshire and Derbyshire collieries to the South and West of England, and the return of empty wagons to the mining areas. To increase the working efficiency of the yard the L.M.S. Railway Company prepared a comprehensive modernisation scheme some years ago. The first part of this scheme, which was completed in 1939, involved the reconstruction and mechanisation of the down section of the yard, where the empty wagons are marshalled for return to the collieries. The reorganisation and mechanisation of the up section of the yard, which formed the major part of the scheme, had to be deferred owing to the war and work on it was not started until April, 1948. In this part of the yard the loaded coal wagons arriving from the collieries for miscellaneous destinations are sorted into direction order to enable full trains to be assembled for dispatch. Work on the mechanisation and modernisation of this up yard has now been completed at a cost of some £800,000. It was carried out in a number of stages without stopping the flow of traffic.

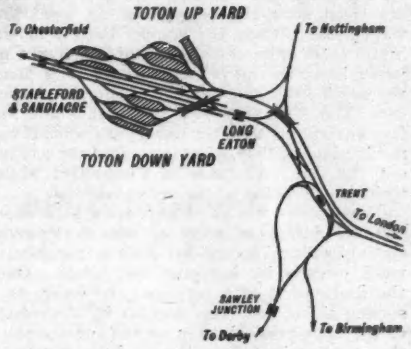
The general lay-out of the complete marshalling yard, which extends over 1½ miles between Long Eaton and Stapleford and Sandiacre, can be seen in the map we reproduce on this page, and the arrangement of the reorganised up yard is shown in the accompanying diagram.

In this scheme of reconstruction half a million tons of earth have been excavated for up yard enlargement and readjustment of levels, 16 miles of track were removed and replaced by 27 miles of new lines, a number of new buildings have been erected and rail brakes and modern signalling installed.

New structures, include four main line signalboxes, hump room, control tower and staff accommodation. Rail brake pits and a subway have been constructed, and a special railway signalling system incorporating relay interlocking has been installed for use at the hump, together with electro-pneumatic operation of all points in that area. Electric lighting, loudspeaker communication between control and operating staff, and improved main line connections, together with rail brake and power-operated points leading from the new hump into the sorting sidings, were also installed. Each of these installations was brought into use simultaneously with the major stages in which the yard reconstructional work had to be planned.

Under the old system all the points leading into the up yard sorting sidings were operated mechanically from a series of cabins. This method was abandoned in the new lay-out and replaced by power operation combined with automatic working, a throughout route being set up by means of push-button controls by one man at the hump. The new yard was designed for remotely controlled rail brake operation, in substitution of the former method of controlling the speed of running of vehicles from the hump by means of the hand brakes of wagons.

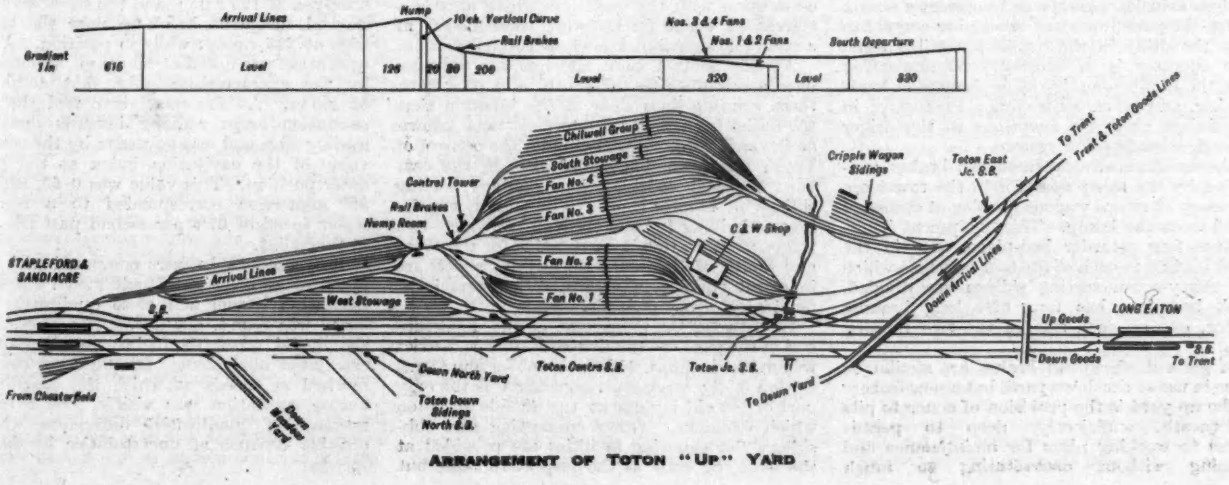
There are now ten arrival lines for the incoming trains of loaded wagons, and on these lines the wagons are inspected and uncoupled into the necessary "cuts" of one or more ready for sorting. Each train in turn is then pushed



TOTON MARSHALLING YARD

by a diesel-electric locomotive over a single line hump with an initial falling gradient of 1 in 20. From the hump the cuts run by gravity into one or other of thirty-seven sorting sidings. Entrance to each of the ten new arrival lines is controlled from the Stapleford and Sandiacre signalbox. Each line can hold up to seventy-five wagons with engine and brake van and is dead straight between the diverging and converging ends. An independent run-round road is provided on one side of the lay-out for the return of the shunting engines after they have pushed their trains over the hump. A view of the arrival sidings taken from the hump is given on page 654. In these sidings humping is controlled by lunar-white position-light signals repeated at intervals along their length. Each of three aspects can be displayed on a signal—hump at normal speed, hump slowly and stop. Round the hump itself a series of signals has been grouped to give the driver of a shunter as continuous sight as is possible. These signals are operated from the main hump control room at the apex of the hump.

The main hump room is to be seen on the right of the view of the hump on page 654 taken from the sorting sidings. Through the large curved windows of this room the



ARRANGEMENT OF TOTON "UP" YARD

operator at the control panel has a clear view of the arrival sidings and the entrance to the sorting sidings. The operator in this room sits behind a panel of push buttons numbered from 1 to 37, each of which represents a sorting siding. The number of the siding for which each cut of wagons is destined is chalked on the end of the wagon or group of wagons in a cut whilst the train is standing in the arrival siding. As the train is pushed over the hump the operator depresses the appropriate siding button and also one of a small bank of push buttons to indicate the number of wagons in the cut, which may be up to six.

Depression of the siding selection button electrically transmits the destination of the cut to a control tower adjacent to the main point area leading into the sidings. This action stores the information preparatory to setting the points leading to the siding as they are freed after the passage of the preceding wagon cut. When the second button in the hump room is depressed it prints on a moving paper band on the rail brake operator's panel the destination and number of wagons in each cut. This "cut indicator" system, which was first introduced upon the down yard when it was mechanised in 1939, eliminates need for making out cut lists and cards in manuscript whilst trains are standing on the arrival sidings.

The track from the hump apex to a short distance inside of each of the thirty-seven sorting sidings is divided into a number of track circuits by insulated rail joints. Once the destination of a cut from the hump to a sorting siding has been decided by depression of the appropriate button on the control panel the route to be followed is set by a system of electrical relays. These relays cause the power-operated points to move where necessary in readiness for the approaching cut of wagons, providing the preceding cut has cleared the track circuit which covers the points in question. The system has been designed to store at least as many route directions as the number of consecutive cuts likely to be on the move on the track circuiting area from the hump to the sidings at one and the same time.

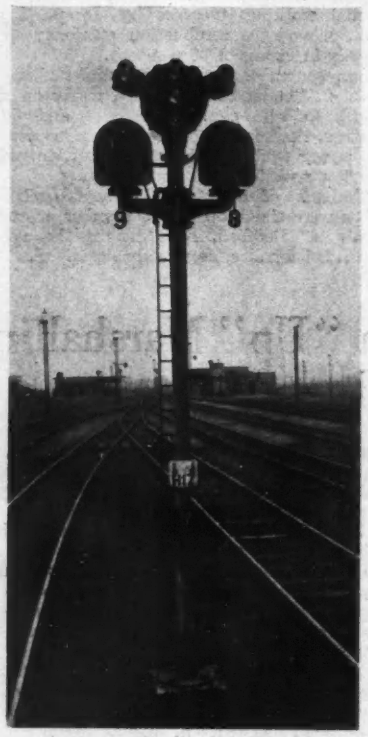
At one side of the main point area leading to the sorting sidings is the three-storey control tower. From the operating room in the top storey of this tower there is an uninterrupted view of the whole working area, and an impression of this outlook can be obtained from one of the illustrations. The operator on the right in this illustration is at the rail brake control cabinet, and the one on the left at a control panel which gives a diagrammatic lay-out of the point area. On this panel lights show the position of the points and occupation of the track circuits, and on it the "cut indicator" band is repeated. The operator at this control panel maintains a constant watch over the sorting operations and he can, when abnormal running or exceptional conditions arise, switch the points concerned to "non-automatic" and control them individually at will to suit the conditions. All of the points are worked electro-pneumatically. With the system, if it is necessary to send a shunting locomotive from the hump to the sorting sidings to close vehicles together or to correct a wrong shunt, the panel operator takes over control to clear the delay in the quickest possible time. This operator is in constant communication with the hump room by microphone and loudspeaker, and when controlling a locomotive in the sidings gives his directions to the driver through a loudspeaker system.

The hydraulically operated rail brakes controlled by the other operator in the tower are necessary to retard wagons running at excessive speed from the hump. This equipment incorporates four retarder bed-plates, one in the track leading to each of the four fans into which the thirty-seven sorting sidings are divided. Each bed-plate has four 62ft long braking beams, one on each side of the two running rails.

In general, these rail brakes are similar to those in use at the down yard, but a new feature at the up yard is the provision of concrete pits underneath, sufficiently deep to permit access to working parts for maintenance and cleaning without necessitating so much interruption of yard operations. All four pits are connected at one end to a subway, which can also be used by anyone to cross the yard without exposure to moving vehicles.

The compact air-hydraulic accumulators for supplying the necessary rail brake pressure are housed in the control tower machinery room on the ground floor.

The leads into the sorting sidings are designed to equalise as far as practicable the track resistance to wagons running from the hump and to avoid appreciable differences in distance from the hump to the physical clearance point at the entrance of the sidings. Apart from a connection immediately on the descent side of the hump to facilitate liberation of locomotives, the first split is at the "king" points, the next



SHUNTING SIGNAL IN ARRIVAL SIDINGS

two at "queen" points, and the next four (beyond the retarders) at "jack" points. From here the sidings diverge into fans of eight, ten, ten, and nine respectively.

The two fans nearest the main line, generally referred to as the west yard, are classified to receive wagons to be made up into trains mostly for the West of England, the longest siding holding seventy-nine wagons and the shortest sixty-three. They converge in proximity to a connection with the main line which affords a convenient egress for the west, controlled from a main line signalbox known as Toton Junction.

At this point a main line junction diverges over goods lines to the south, and it is with these running lines clear of the junction that the outlet from the two outermost fans, known as the east yard, connects, under the control of Toton East Junction signalbox. In the east yard physical considerations enabled sorting sidings of greater length to be laid down, the longest holding 102 and the shortest eighty-two wagons. With this lay-out trains for the West and South of England respectively, which are in about equal proportions, can depart independently of one another.

In between the main split at the departure end of the yard are the British Railways district wagon repair shops, which, except for a modernisation of the serving arrangements, is the only part of the old lay-out at the up side at Toton which remains. Other connecting and subsidiary flat shunting facilities are provided at the outgoing ends of the respective fans, but physical limitations precluded the incorporation of groups of departure lines.

In the communications system thirteen two-way loudspeaker circuits have been installed between key points and to facilitate communication with staff in the open. These circuits are energised by depressing the appropriate key in a cabinet in the hump room or control tower or by pressing a waterproofed microphone button at an outside calling point. Multiple loudspeakers have been installed where it is necessary to cover an outside area.

In an extensive telephone system most of the circuits are multi-station "railway bus" lines, but at any point with more than one or two separate instruments a telephone "concentrator" has been provided.

It should be mentioned as a matter of interest that the Toton yards are open throughout the whole twenty-four hours and the up yard receives up to seventy trains daily and dispatches about sixty. The total number of wagons sorted during twenty-four hours varies between 3000 and 4000, the average number of wagons per cut being between two and three. Up to the present the highest number of wagons shunted over the hump in twenty-four hours is 3948 and in one eight-hour turn of duty 1549.

Photography at Sea of Ship Propeller Cavitation

ON October 26th a paper entitled "Photography at Sea of Ship Propeller Cavitation," was read before the North-East Coast Institution of Engineers and Shipbuilders, by J. N. Fisher, B.Sc., Ph.D., of the Royal Naval Scientific Service, and is summarised below.

The paper gives an account of direct observation and short duration flash photography of the cavitation on the blades of a ship's propeller and also the reasons why cavitation tunnel tests do not exactly simulate full-scale conditions at sea. Two thick glass ports were fitted in the shell plating at 16in centres; one was covered by a lamp having a high-intensity short-duration flash, synchronised with the propeller shaft, and the other was used for visual observation or for taking photographs. Owing to the large camera aperture used and the high-speed film it was found necessary to work at night to avoid fogging by diffused daylight and the flash from a 50 m.f. condenser was used for photography and a 4 m.f. for visual observation.

To ensure correct interpretation of the photographs the blade periphery was marked out and photographed in two positions "A" and "B." Pictures taken with the blade in position "B" showed the points of flow breakaway on the leading edge and those taken in position "A" localised the sheet cavitation at the trailing edge.

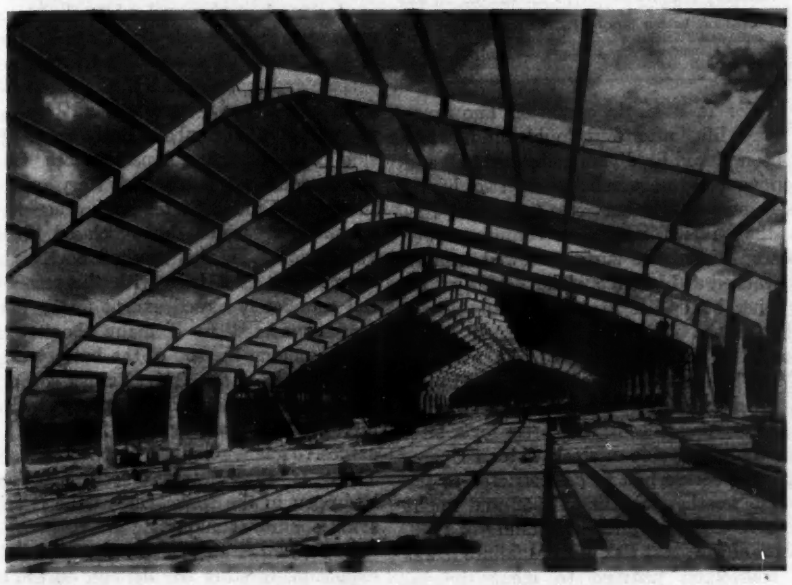
The propeller observed had a diameter of 8·25ft and a pitch of 9·25ft, and the photographs showed that there was sheet and bubble cavitation. Bubble cavitation was first observed at 175 r.p.m. and the sheet cavitation showed turbulent break-up near the trailing edge at 225 r.p.m., while in position "A" tip cavitation was noted at 80 r.p.m., accompanied by the characteristic noise first audible at 65 r.p.m. As the speed increased the sheet cavitation crept radially inwards down the leading edge and was governed by the constant value of the cavitation index at the break-away position. This value was 0·65, which at 8ft immersion corresponded to a resultant water speed of 67ft per second past the blade at this point.

The photographs were compared with those taken of a one-eighth scale model screw in a cavitation tunnel and close qualitative similarity was found, but it was necessary to run the model screw at higher speeds than the calculated equivalent. Discrepancy was most marked at speeds at which the onset of tip vortex cavitation was visible, but a reliable estimate of quantitative differences was not possible because of uncertainties in the ship speeds.

A Precast Concrete Framed Building

THE Whieldon Works of Doulton and Co., Ltd., an extension of which is described in this article, specialises in the manufacture of sanitary earthenware and vitreous china. Previously all the firing there was carried out in a number of coal-fired intermittent kilns known, because of their shape, as "bottle kilns," but they are being replaced by two "Dressler" continuous gas-fired tunnel kilns. These new kilns are each about 320ft long and the new building described herewith has been designed to house not only them, but all the processing after the first, or "biscuit," firing.

The two new tunnel kilns with their attendant processes are placed at first floor level. The ground floor provides facilities for testing, assembly, storage, packing, and the despatch of finished goods. As a result of these new arrangements it has been possible to reorganise the earlier stages of manufacture carried out in the existing buildings; that is to say, from the processing of the raw materials up to the completion of the unfired or "green" ware.



PRECAST STRUCTURE AT FIRST FLOOR LEVEL

The two kilns have different functions; one produces unglazed or "biscuit" ware, the other glazed or "glost" ware. To maintain an unbroken flow in production the kilns are ranged side by side and head to tail down the centre of the building. "Green" ware is delivered to the north end of the new building at first floor level. It is then passed through the "biscuit" kiln to emerge into a spacious working area, where it is inspected, brushed, glaze applied, and dried ready for the next firing. During this second or "glost" firing, which the other kiln performs, the ware is returned to the northern end, where it receives a final inspection and is then transferred by lift to the ground floor.

CONSTRUCTION

The site of the new building is separated from the remainder of the factory by a canal, and it has been necessary to construct a bridge of 130ft span carrying a conveyor. Because of the fact that the site consisted largely of made-up land and the load bearing capacity was therefore poor, the whole building is founded on a system of in situ piles—good load-bearing stratum being found at from 20ft to 30ft—to minimise any danger of subsequent differential settlement and the damage which this might cause to the kilns.

Up to and including the first floor slab all the construction with the exception of a small annexe to the east is in situ concrete framed. It is on this construction that the load of the kilns is carried. Columns at 15ft centres divide the building lengthwise into thirty-two equal bays; main beams run longitudinally and span the 15ft from column to column, and secondaries at 7ft 6in centres span transversely between the main beams. The suspended slab of the first floor is 5in thick and cast integral with the beams. At the ground level the pile caps are connected by a series of sill beams, but in general the ground floor slab is not suspended; where concentrated loads have to be carried it is, and the sill beams and slab are then cast integral. Everywhere else paper joints separate the one from the other.

From first floor slab upwards the construction changes from in situ to a proprietary precast system of framing, which is shown in our illustration, and of which the span is 85ft. Spans in framing of this kind have been steadily increasing for some time past, and although that at Whieldon has been exceeded in France by one from the same designers, this of 85ft is thought to be the largest yet erected in Britain. The framing consists essentially of transversely spanning portals spaced at 15ft centres, which carry precast purlins 4ft 6in apart and special gutter units along the eaves.

Each main cross spanning portal is made up of four separately cast members with a system of scarfed jointing at the connections, which maintains the required degree of structural continuity. The leg members are L-shaped; they weigh about 2¼ tons each. The rafter elements weigh about 1¼ tons apiece and, despite their span, are only 18in by 7in in sectional area. Laterally the stiffness and structural rigidity comes from the purlin and gutter units, with the method of jointing used at their connections. To form these joints U-shaped bars projecting from the ends of both types of unit are looped round fixing bolts that protrude upwards from the backs of the rafter principals; a nut and large washer is tightened over each bolt, which grips and holds the U-bars in place. The joint is then completed by filling the 2in wide gap formed between the ends of the units with grout. All the precasting for the main frames was carried out at the site and the smaller units—purlins, gutters, roof slabs, and so forth—were all factory made. Main frame sections were actually cast on the first floor slab itself, and, to save handling, as near as practicable to the places in which they were ultimately to be used. Because wheel loads from a mobile crane would have been too great for the slab to withstand, the lifting was performed with four guyed timber poles, blocks and hand-operated winches. After being lifted into position the leg members were plumbed and lined up along the scarfings and kept in line by temporary scaffold frames. These units were dowelled at the foot with the in situ concrete of the lower storey and during the placing were wedged accurately into position in holes preformed in the first floor slab. They were lined on the external faces with those of the columns below by temporary clamps. The lifting and placing of the rafter members followed and it was not until they had been bolted up that the weight on the poles was eased and the dowels grouted up. Erection of purlins and gutter units followed immediately behind the erection of the portals. The wall infilling of the reinforced concrete framing is in 11in cavity brickwork. The windows are metal casements which on the first floor extend from column to column and uninterruptedly from end to end of the building. For the main roof the covering is asbestos cement corrugated sheeting. The consulting engineers for this work were W. S. Atkins and Partners, and the contractors C. Cornes and Son.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

JOINTING MATERIALS AND COMPOUNDS

No. 1737 : 1951. This standard is concerned with the material, composition, strength, sizes, general conditions of tests, &c., of compressed asbestos fibre, vulcanised fibre, plain rubber, rubber insertion (reinforced with cotton fabric or with flax fabric), and corrugated metal joint rings. Clauses are included relating to the essential requirements to ensure the soundness, resistance to corrosion and disjointing properties of jointing compounds. The methods for testing the various materials are covered in a number of appendices. The section dealing with vulcanised fibre is based on the appropriate parts of B.S. 216, "Vulcanised Fibre (Natural Colour) Sheets for Electrical Purposes," while the sections concerned with rubber and rubber insertion have been prepared by the committee dealing with the standardisation of rubber rings for joints in pipes. The whole of Appendix O has been extracted from B.S. 903, "Methods of Testing Vulcanised Rubber." The section relating to jointing compounds has been based on B.S. 1260, "Jointing Paste for Flange and Similar Type Joints," and B.S. 1261, "Jointing Compounds for Screwed Joints." The materials and compounds are for use with screwed, flat-faced flanged and flat-seated joints for cold water (up to 300 lb. per square inch), hot water (up to 50 lb per square inch and 100 deg. Cent.), town gas (up to 50 lb per square inch). and saturated steam (up to 30 lb per square inch). Price 5s., post free.

GROMMETS FOR GENERAL PURPOSES (RUBBER AND RUBBER-LIKE MATERIALS)

No. 1767 : 1951. In this specification no attempt has been made to specify all the materials from which grommets can be made as it is realised that materials may be developed in the near future, which may be satisfactory in every way. Attention has, therefore, been confined to the natural rubbers and synthetic rubbers and rubber-like materials, such as polyvinyl chloride, which were being used at the time this standard was prepared.

Minimum physical test requirements are laid down, together with some additional tests to meet special requirements. A table of dimensions for a standard range of grommets from ¼in up to and including 3in is included. An appendix sets out a suitable method for testing the resistance to exposure cracking of rubber and synthetic rubber grommets. Price 2s.

METHOD FOR THE DETERMINATION OF TIN IN FERRO-TUNGSTEN AND TUNGSTEN METAL.

No. 1121, Pt. 22 : 1951. The method described in this standard is based on the isolation of tin as the sulphide using molybdenum sulphide as a carrier. Tungsten is retained in solution as a complex with ammonium citrate.

The tin is reduced to the bivalent condition with metallic aluminium in the presence of an antimony salt and the reduced tin titrated with standard iodate solution. Price 1s., post free.

THE ENGINEER

Vol. CXCII NOVEMBER 23, 1951 No. 5000

Contents

PAGE

LEADING ARTICLES—
H.M. Submarine "Affray" ... 658
Mechanisation of Building Work ... 658

SPECIAL ARTICLES—
Compound Locomotives, 1901. (Illus.) ... 662
End of an Era. No. II. (Illus.) ... 642
Hydro-Electric Power in the Isere Catchment of the French Alps. No. I. (Illus.) ... 644
Number 5000 ... 659
Some Fuel and Power Projects ... 664

Engineering Exhibition Hall and Cinema ... 672
Heavy Hydraulic Presses. (Illus.) ... 670
Measurement and the Power Transmission System ... 668
Modernisation of Toton "Up" Marshalling Yard. (Illus.) ... 655
Photography at Sea of Ship Propeller Cavitation ... 656
Precast Concrete Framed Building. (Illus.) ... 657
Variable Capacity Pump for Corrosive Fluids. (Illus.) 672
Whale Factory Ship "Juan Peron." (Illus.) ... 666
Works of the Steel Company of Wales. No. IV. (Illus.) ... 649
1000kW Marine Gas Turbine Set. No. II. (Illus.) ... 652

PAGE

LETTERS TO THE EDITOR—
Early History of the Gas Engine ... 661
Industrial Revolution ... 661
Gas Turbine Manual ... 661
Spirit of Brunel ... 661
Whitworth Register, 1951 ... 661

LITERATURE ... 660
Books Received ... 660

A SEVEN-DAY JOURNAL ... 641
Building Exhibition
Education for Management
Electricity Corporation of Nigeria
Fuel Research
International Institution for Production Engineering
Single-Phase, 50 c/s Electric Traction Trial in the U.K.

NEWS AND NOTES—
American Engineering News. (Illus.) ... 671
Australian Engineering News ... 669
British Patent Specifications. (Illus.) ... 675
British Standards Institution ... 657
Contracts ... 674
Forthcoming Engagements ... 676
French Engineering News ... 672
Industrial and Labour Notes ... 673
Launches and Trial Trips ... 676
Notes and Memoranda ... 674
Personal and Business ... 674

H.M. SUBMARINE "AFFRAY"

WHEN some three months ago Mr. Churchill asked the former Parliamentary Secretary to the Admiralty whether a great expenditure of effort would not be worth while to salvage the "Affray," he was unquestionably voicing the universal desire that every practicable step should be taken to ascertain the cause of the disaster. By then the whole length of the submarine had been examined by divers from the diving vessel "Reclaim," and it had been established that the hull, superstructure and external fittings, apart from the snort tube, were undamaged. But the divers, who had been assisted and directed by television, had no means of gaining access to the interior of the vessel—for all the hatches were closed and firmly clipped down from the inside—and it was becoming evident that no more information would be obtained unless she could be brought to the surface. Diving operations were, however, continued while the fine weather lasted, and it was not until last week that the First Lord, Mr. J. P. L. Thomas, informed the House there was no longer any reasonable hope of obtaining further light on the problem by this means and that the "Reclaim" had been ordered to resume her normal work of training deep sea divers. He added that after the fullest consideration it had been decided not to attempt salvage. That it will not now be possible to establish the cause of the accident will be a keen disappointment, not only to the Admiralty, but still more to the officers and men of the submarine branch who already have to accept many known risks inseparable from service in submarines. The public will also no doubt wonder why it is impracticable to raise the "Affray" in view of the successful salvage of the submarine "Truculent" last year. The First Lord evidently had all these considerations in mind when he made his statement to the House, for he went very fully into the reasons for the decision, which, he pointed out, now had the support of the Prime Minister. The "Truculent," it will be remembered, sank, after a collision on the surface, in relatively shallow and sheltered water off the Thames estuary. She was brought to the surface at low water in a single operation known as "a power lift," after four double 9in hawsers had been placed by divers under her hull and taken to 600-ton purchases in two lifting vessels moored over her bows and stern. She was then raised until her conning tower appeared above the surface, towed inshore and beached at high tide. The "Affray," on the other hand, lies in 48 fathoms—nearly 300ft—in the vicinity of the Hurd Deep, exposed to the full force of the weather. As Mr. Thomas emphasised, work could only be carried on in fine weather and, because of the very strong tides in that area, for a brief period on either side of slack water. Operations would have had to be restricted to the five fine weather months of 1952 and might well have extended into the summer of 1953. In view of the great risk of total failure it was not considered justified to incur the inordinately high cost and the substantial diversion of our resources which would be entailed by the employment of seven or more vessels urgently required for other work.

Those are sound and convincing reasons for not attempting salvage. But the First Lord laid himself open to criticism when he discussed the theories which have been advanced to account for the accident. In spite of the defects in the metal of the snort, since discovered under test, he discounted the possibility that the snort snapped while in use and that the submarine flooded through failure to close the valves provided. In those circumstances, he said, she would have sunk stern first, whereas the evidence suggests that the stern is undamaged. None the less, the after part of the ship may well be flooded even though undamaged. Moreover, cases have occurred when the crew of a submarine on the surface were rendered temporarily helpless to take action of any sort due to the diesel engines exhausting the air in the vessel in a few seconds, after the air supply had been cut off by the conning tower hatch closing in a heavy sea. There is a need for an extra valve at the foot of the snort tube, which would close automatically on the entry of a large volume of water, and it is satisfactory to note that consideration is now being given to the fitting of this additional safeguard. Might it not also prove desirable to link the operation of that valve to the engine controls so that the engine would automatically be closed down should the valve operate? The First Lord went on to suggest the possibility of a major battery explosion starting a "shock wave" in the vicinity of the hull, which could have ruptured the pressure trunking lying amidships under the casing, but external to the hull. Damage of this type, he suggested, would have resulted in the submarine sinking on an even keel and could have started a crack in the snort which might then have snapped off as she grounded. There seems no more solid basis for this theory, however, than for any other put forward, since the effects of previous battery explosions in submarines have, in the main, been confined to the battery compartments and have never incapacitated the whole crew. It will be recalled that the U.S. submarine "Cochino" did not sink for several minutes after a *series* of heavy battery explosions had occurred while she was proceeding at periscope depth, using her snort, in August, 1949. She was able to come to the surface and make signals for help and all but seven of her crew were rescued by another submarine which subsequently came alongside her. British submarines are in any event much less liable to battery explosions than are United States and other foreign submarines, which have closed battery ventilation. In this method each cell has a small air inlet hole, with the rest of the cell completely closed except for an ebonite pipe connected to a main ebonite trunk running along the top of the battery tank to an exhaust fan. The British open cell method allows each cell to discharge hydrogen into the large battery tank from which this explosive gas is removed by the exhaust fan. There is thus far less concentration of hydrogen in the tank than in the relatively small ebonite trunking.

But whether or not there was a battery explosion, whether the damage to the snort was the result of some sudden catastrophe, whether the damaged snort was a direct reason for the flooding of the ship, or whether continued running of the engine, after damage to the snort, rendered the crew powerless, will never be known and there can be no useful purpose in continuing to speculate on what happened. One thing, however, is quite clear from the careful examination which has been carried out on the hull—no attempt was made to release the mark buoys or to use the escape apparatus. The end clearly came suddenly and swiftly.

THE MECHANISATION OF BUILDING WORK

THE building industry, or at least that part of it concerned with the building of small houses, is the *bête noire* of the student of productivity and still remains to a large extent unchanged by modern industrial techniques. On the occasion of the Building Research Congress last September, Sir Ben Lockspeiser, Secretary of the Department of Scientific and Industrial Research, in a concluding address to the Congress, criticised the conservatism of the industry and said bluntly that it was, to one degree or another, either unwilling or unable to learn. We hope that future events will not support this criticism, for a good deal of research work, some of it

very valuable, has been carried out to find more economical and sounder methods of house construction. We recently attended a demonstration organised by the Building Operations Research Unit of the D.S.I.R. of a study of this kind. It was concerned with the use of tower cranes for the construction of blocks of flats and of houses.

The tower crane is a familiar sight on the Continent, where it has been in use for many years. The import into this country of some of these cranes has recently been permitted, and a description of one example of them was given in our last week's issue. They have the advantage of giving a long reach, unaffected by obstructions below the level of the jib, which is placed horizontally at the top of the tower, the crane being rail-mounted. The crane that we saw at work was concreting the roof of a six-storey block of flats. The concreting required a gang of only five men—two spreading the concrete, the crane driver and two men at the mixing station. This station consisted of a small weigh-batching unit, supplied from stock piles by an excavator fitted with a grab and feeding a 14/10 concrete mixer, which discharged directly into the crane skip. For a horizontal travel of 200ft (the entire length of a block of flats) and a lift of 60ft, the cycle of operations of the crane took about four minutes. For smaller horizontal distances the controlling factor was the concrete mixing time. These figures will give an idea of the usefulness of such a crane for the construction of fairly large buildings. It is with smaller cranes, however, that the Building Operations Research Unit is mainly concerned at present in its investigations. One of the main drawbacks of building work in small houses as it is carried out at present is the large amount of handling of materials, much of which is moved, by hand as a rule, twice or even three times. By the use of a small tower crane, simply and cheaply built, with a height and reach just sufficient for a pair of semi-detached houses, the handling of materials can be simplified and cheapened. To use the crane to the best advantage, however, the programme of construction must be organised round the performance of the crane, and the lifting devices, such as pallets for lifting bricks, which are being developed for use with it. Such organisation results in the employment of more craftsmen—perhaps twice as many—and less labourers—perhaps half as many—as are generally employed at present. In this way a saving in construction time and hence in overhead costs results.

The construction of as small a unit as a pair of semi-detached houses evidently does not lend itself easily to the application of such processes as time and motion study, or mechanisation, or other methods whereby productivity is improved. Yet the semi-detached house, which is found to a large extent only in this country, is still the most popular form of construction, so that a good deal of research has been carried out to find ways of building it more efficiently. A reduction of redundant and uneconomic handling of materials is the most obvious first improvement to make. Therefore, since the war many machines such as powered barrows and skips, transporter booms and hoists of various kinds have been introduced. The most recent study is that of the small tower crane, with its appropriate handling accessories, which promises to be a substantial contribution to efficiency, not only by virtue of its direct advantage of reducing the cost of handling but also by the incentive it gives to plan the work properly. That such planning is essential for a satisfactory level of productivity is well known, and it is partly because of its absence, compared with the organisation of larger building and civil engineering works, that the small builder is so severely criticised. However, when a small crane of the kind under consideration, or perhaps even some other of the forms of handling equipment mentioned above, is employed on a housing site, it becomes the largest item of plant on the site, so that its performance provides a pacemaker for the rest of the work, thus demonstrating the advantages of a sound construction programme and site lay-out. The recent study of the tower crane, which the D.S.I.R. has carried out, it may be noted, was not inspired by the example of practice in the United States, as is so often the case with investigations of productivity, but by Continental practice. Tower cranes have been in use in Germany, France and Switzerland for twenty or twenty-five years. It is somewhat surprising that their advantages have only just been examined in this country.

Number 5000

TO-DAY we publish the 5000th issue of THE ENGINEER. It is, we feel, an occasion which our many readers at home and overseas would not like to pass unnoticed, and an occasion on which we may be permitted to express, quite humbly, a measure of our satisfaction at what we have been able to achieve. Week by week—with only four exceptions—since January 4, 1856, we have endeavoured to record, as faithfully as possible, events and developments in the engineering and allied industries; events and developments which, as the years have passed, have exercised an increasing influence on the daily life of the world and the welfare of its peoples.

In making mention of this, our 5000th, issue we do not propose to embark upon a survey of the progress of engineering since this journal first saw the light of day. We feel, however, that we may be permitted to recall that, in our first number, we outlined our "mission" by saying: "Our intention is not to furnish a dry register of the progress of machinery. That in itself is no doubt a highly useful purpose, and one which we hope to fulfil so completely as to give us a legitimate claim to the support and sympathy of the constructive mechanic. But our aim is higher; it is our hope and purpose to represent effectually the industrial activity in which we live, to keep pace with the progress of—and improvement and development in—all those departments of the arts and manufactures which contribute to our material comforts. We have considerable confidence that little will escape our notice worth placing before our readers." Incidentally, the first issue of THE ENGINEER consisted of twelve editorial pages enclosed in four pages of advertisements. The advertisements in that issue emphasised perhaps the broad outlook of engineers, for that printed at the head of the first column of the first page announced:

> Royal Polytechnic. Christmas Holidays. The Second Part of the VOYAGES of SINBAD the SAILOR, with new and beautiful DISSOLVING PICTURES, and description, with SONGS by Lenox Horne, Esq. Laughable PHANTASMAGORIA effects by Messrs. Carpenter and Westley. Series of astonishing CONJURING TRICKS and DELUSIONS, by Mr. Burmain. Brilliant Popular Lectures on FLAME, FIRE, and COMBUSTION, by J. H. Pepper, Esq. Third GRATUITOUS DISTRIBUTION of the ORNAMENTS of the GIANT CHRISTMAS TREE, on Wednesday, January 9 h, at One and Seven, being the SPECIAL JUVENILE MORNING and EVENING of the week, for which great amusements will be provided.

It ought to be added here that the first issue contained the announcements of at least four firms who still regularly use our advertisement pages.

The aim of THE ENGINEER, as expressed in its first issue, has been pursued throughout the 5000. From the beginning, we have taken the whole field of engineering as our province. It was a field that was limited in the 'fifties of the last century, and when it is recalled how rapidly that field has extended, the difficulties of covering it fully in our pages will soon be appreciated. By the time we reached the 1000th issue in 1875 we were describing the concrete foundations for a 60-ton crane in Glasgow harbour; some "direct-acting rolling mill engines," which had been installed in the Panteg steel works; and—with a two-page drawing—a printing, folding and binding machine, which had been set to work in New York. Moreover, about the same time, in fulfilment of that earlier declaration that "little will escape our notice," we recorded that:—

> A Californian genius is the author of a new invention intended to do away with servants around the table at meal times. It consists of a movable railway, acting within a circle inside the plates that are to be served. It will suffice for an oblong table as well as for a round one, and is operated by the person who sits at the head, or, in other words, the one who does the carving. This individual is enabled, by means of his or her feet under the table, after the manner of working the treadle of a sewing machine, to send a plate of hash, so to speak, sailing round at lightning speed to the spot of destination, followed up with the condiments, cutlery, &c., necessary to the thorough enjoyment of the meal. The advantages of such an improvement are apparent and manifold. Besides the delays and confusion consequent upon the prevailing custom, accidents, such as spilling soup over the shoulders of those seated around the table, will be avoided.

The 2000th issue brought THE ENGINEER to the middle of 1894. By then it was becoming more and more evident that the field to be covered was rapidly extending. We were describing such works as the enlargement of Liverpool Street Station, and a concrete bridge, 131ft 9in in length, erected at the Antwerp Exhibition. We recorded the speed trials of a cruiser, built for the Chilian Government by Sir W. G. Armstrong Mitchell and Co., and equipped with twin-screw, triple-expansion engines by Humphrys, Tennant and Co. We also commented, in a leading article, on the "decline in the consumption of gas in the metropolis, as well as in some other parts of the Kingdom," pointing out that the competition of electric light was such that the statistics of the gas companies, especially in London, must be expected to reveal the existence of some check on the progress of the older style of illumination. Finally,

in a few words, THE ENGINEER reported that two or three firms had conceded the forty-eight-hour week. Our view was, however, that the main body of employers continued convinced that the adoption of the eight-hours' day "would only mean a repetition of the well-remembered effect of the introduction of the nine-hours' system, and that there would be a further curtailment of productive capacity, alike by machinery and hands, together with a necessary rise in dead charges."

The century which saw the birth of this journal came to an end, and there opened the present century, in the first half of which a multitude of scientific and technical developments has occurred; and in which THE ENGINEER, like the industry it represents, has had to bear the strain of two world wars and their aftermath. Our 3000th issue, which was published on June 27, 1913, contained a lengthy leading article "contrasting the engineering of the 1850s with the engineering of to-day." It referred extensively to railway development, locomotive design, marine progress, ordnance, civil engineering works, machine tools, and electricity, though there was no comment upon aeronautics. But the same issue reported an Italian aero-naval review, near Turin, in which there took part "forty military aeroplanes piloted by officers of whom the greater part had seen constant service, with their machines, in the Tripoli campaign." The note about this event concluded by saying that "the review terminated happily and the air fleet returned without any untoward incident."

Before we reached our 4000th number, on September 9, 1932, the first break in regular weekly publication had occurred. The major industrial disaster of this century, the general strike, compelled THE ENGINEER to suspend publication of the two issues that should have appeared on May 4 and 11, 1926. In 1932 this country was beginning to show signs of recovery from the economic and industrial depression which followed the general strike. But in reminding our readers of the appearance of our 4000th issue, we felt able to write that "the support which the engineering and allied industries have given to this old, but ever young, paper during the depression gives us reason to believe that some twenty years hence THE ENGINEER will be able to record the completion of another thousand numbers and start upon its sixth millenial unimpaired in vigour."

To-day we are happy to record the completion of "another thousand," bringing THE ENGINEER to No. 5000. In the span covered by this latest thousand issues, there has been a rapid succession of technical and industrial changes to place on record. Many of our pages have been occupied with the tragedies and triumphs of the second world war, and with the economic and other difficulties which have faced the world since. One of those difficulties, the fuel and power crisis of February, 1947, was responsible for the second break in the regular weekly publication of THE ENGINEER. Power supplies were reduced to a bare minimum and the Government decreed that the printing of periodicals must stop for two weeks, which meant that no issues of this journal, dated February 21 and 28, 1947, could appear. Thus the shortages following the war did what the war itself never succeeded in doing! For, although our offices and the works of our printers suffered several times between 1940 and 1945 from "near misses" in aerial bombardment, the weekly publication of THE ENGINEER was on no occasion more than a few hours behind its appointed time. With this in our minds, a final word about our printers is not inappropriate. From its beginning, the paper has been printed by George Reveirs, Ltd.—three generations of the Reveirs family have indeed served it faithfully.

THE ENGINEER now looks forward to its sixth millenial. It will strive, as it has done over the last ninety-five years or more, to live up to its original aim "to keep pace with the progress of all those departments of the arts and manufactures which contribute to our material comforts," and to represent effectually the industrial activity in which we live.

Literature

Stainless Iron and Steel. Third edition, Vol. I, "Stainless Steels in Industry." By J. H. G. MONYPENNY. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 45s.

WHEN the first edition of this book was published in 1926, less than three years had elapsed since the introduction into this country of the austenitic chromium-nickel steels under the names of "Staybrite" and "Anka," and the engineering applications of stainless steels were only beginning to be realised. Mr. Monypenny's book fulfilled the very important functions of assembling the metallurgical data on the constitution and treatment of stainless steels, and of placing at the disposal of designers information as to the possible application of the various products. This was accomplished in 304 pages. In 1931 the same task needed 575 pages. Now, two substantial volumes are required to deal with the two aspects of the subject. The first volume, "Stainless Steels in Industry," is not concerned with details of constitution and microstructure, but it contains sufficient description of metallographic features to explain the classification of the steels, their response to heat-treatment and their behaviour under the conditions of service required of them. The varieties of stainless steels in commercial use (hardenable, ferritic and austenitic) with their compositions, characteristic features, and properties of particular importance to the engineer and metal worker, are described in the first chapter. The subsequent chapters are devoted to the methods recommended for the fabrication of the steels into useful equipment, and their response under varying conditions of corrosive attack and temperature. In the final chapter consideration is given to factors affecting the selection of suitable forms of stainless steel for specific industries.

Throughout the book, the author's unrivalled knowledge of the subject is evident, and the value of the data presented is enhanced by his personal view as to their validity and relative importance. It is, for example, useful to have his views about the "stabilising" heat-treatment frequently recommended in America for steels already containing titanium or columbium. This, he points out, is really unnecessary and, if applied to sheets and plates before fabrication, generally useless. The conditions for "stabilising" a large welded vessel are described and the process is not quite so simple as, at first sight, it might appear to be.

The very important chapter entitled "How Stainless Steels Resist Corrosion," starts with a warning that "stainless steel is not a panacea for all the corrosion ills that worry engineers." The cause of their remarkable resistance to corrosion is discussed, and their behaviour when exposed to different corroding media is described in relation to their composition and heat-treatment. Local attack due to undesirable temperature gradients in heat-treatment, electro-chemical attack due to contact with other metals, and corrosion fatigue may, in special circumstances, be of paramount importance, and each of these subjects is treated in detail. The importance of corrosion fatigue is fully recognised and instances of this type of failure are given. Stainless steels, whilst they are much better than carbon steels or low-alloy steels in resistance to corrosion fatigue, may have their endurance under alternating stresses very much reduced if corrosion is also present. Superiority in corrosion fatigue may become the determining factor in the selection of one of these steels for engineering purposes.

Rapid advance has been made in the development of corrosion-resisting materials, but possibly not so rapid as in that of the heat-resisting steels. In the chapter on "Behaviour at High Temperatures," the author was hampered by security restrictions from disclosing the latest information, but the account becomes more complete if supplemented by the report of the Iron and Steel Institute's Symposium on High Temperature Steels and Alloys for Gas Turbines.

The last chapter of the book is concerned with the selection of stainless steels for industrial purposes, and here the wide knowledge and experience of the author are placed at the disposal of the designer. It is evident that the use of stainless steel will not overcome every corrosion difficulty, and many such difficulties may be resolved without recourse to this relatively expensive product. If, however, in the light of the advice given in this book, stainless steel of the appropriate type is used in an appropriate place, the probability is that it will result in a great saving both of money and time.

The book retains its position as the standard British treatise on stainless steels, and the new edition will be received with wholehearted appreciation of the way in which the author courageously faced the delays and difficulties which beset the progress of the revision. All who came into contact with the late Mr. Monypenny, in whatever capacity, will be grateful to Professor F. C. Thompson for contributing, as a foreword, a personal tribute to one who was so widely esteemed and respected.

BOOKS RECEIVED

Telephony. Volume II: Automatic Exchange Systems. By J. Atkinson. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 50s.

Thermostats and Temperature-Regulating Instruments. Third edition. By Roosevelt Griffiths. London: Charles Griffin and Co., Ltd., 42, Drury Lane, W.C.2. Price 20s.

Questions and Answers on Refrigeration. Second edition. By M. E. Anderson. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 5s.

Intermediate Engineering Drawing. Third edition. By A. C. Parkinson. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 9s.

Plane and Geodetic Surveying for Engineers, Volume II: Higher Surveying. By David Clark. London: Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 32s. 6d.

Modern Soap and Detergent Industry, Volumes I and II. Third edition. By Geoffrey Martin London: The Technical Press, Ltd., Gloucester Road, Kingston Hill, Surrey. Price 50s. each volume.

A New Calculus, Parts I and II. By A. W. Siddons, K. S. Snell and J. B. Morgan. London: Cambridge University Press, Bentley House, 200, Euston Road, N.W.1. Price, Part I 5s., Part II 10s. 6d.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE EARLY HISTORY OF THE GAS ENGINE

SIR,—Your leading article of November 9th will have been read with satisfaction by all who are interested in the early history of the internal combustion engine, and will serve a useful purpose in reminding engineers that excessive claims on behalf of particular individuals may, if repeated sufficiently often, result in the acceptance of a quite false picture of the early development of an invention.

It is gratifying to notice that you have given due mention to the part played by Barsanti and Matteucci in the development of the gas engine, a part which is too often ignored or forgotten, but which led to the production—admittedly not by the inventors—of the first gas engine which showed a reasonable economy in fuel. There can be no doubt that the free-piston engine, almost always associated with the names of Otto and Langen, sprang directly from the ideas of the two Italians and that the German engine, to quote Sir Dugald Clerk, ".... was absolutely identical with the previous invention of Barsanti and Matteucci, but the details were completely and successfully carried out." No one desires to detract from the great credit which is due to Otto for his pioneer work and for his persistent faith in the future of the internal combustion engine, but the ideas on which his work was based were in the main those of others whose priority should, in justice, be acknowledged. A first step towards this desirable end would be a tacit agreement to ban that misleading phrase "The Otto Four-Stroke Cycle" and substitute for it "The Four-Stroke Cycle of Beau de Rochas." May I respectfully submit this proposal to the notice of all those who lecture on heat engines in our universities and technical Colleges?

L. J. KASTNER

Swansea, November 14th.

THE INDUSTRIAL REVOLUTION

SIR,—Referring to your leader, July 13, 1951, wherein you state that it is a blunder to think the proletarian was called into existence by the invention of steam and other machinery, I agree, but I protest against the implied slur on Marx and Engels, for those two men were probably the first ever to point out "That feudalism shaded off gradually into capitalism," and "There was generally no sharp break between one and the other." Marx over a hundred years ago realised absolute origins could not be discovered; and if one is anxious to fix dates one would have to go back thousands of years, not merely hundreds. For surely we will all agree the Pyramids were not built by cottage industry, for although we are told machines were then used, one would be considered queer if one referred to that period as the beginning of the "machine age" or the start of the proletarian. Over all history there have been leaks in the feudal dam, but a leak is not properly referred to as a burst; but bursts sometimes occur, and most will agree that the burst from feudalism to capitalism approximated to the introduction of the steam engine. Steam may not have been the cause of the burst; no one can now say whether a burst would have taken place, failing the steam engine. A slow progressive enlarging of the leak seems more feasible. Had that been the process, it would at least have obviated learned professors wasting their time proving the obvious. Over and above all this is the fact that there is much evidence to indicate that the factory system did not originate in England, but in India; for all agree that Indian fabrics were far superior to European (English) fabrics at the period when English fabrics hungered for an expanding market; but superiority of Indian fabrics was no match for British rifles. It seems unlikely Indian cottage industry would excel Lancashire machine industry.

Lastly, there is not much truth in the assumption that feudalism is now dead and buried even in England, which still contains a hard core of it. The feudal dam in the Middle East has hardly yet sprung a leak, although that may shortly happen. All of which indicates that to fix beginnings or ends of systems, spaces as well as times and dates must be considered.

A. KERR

Alice Springs, Australia,
September 20th.

GAS TURBINE MANUAL

SIR,—I was interested in reading the discussion (November 9th) concerning the heat equivalent of 1kWh, as to whether it should be 3413 or 3412 B.Th.U. Personally, I make it 3411·6877, using the 1939 Callendar Steam Tables.

1,980,000 ÷ 778·26 = 2544·137.

10,000ft-lb = 13558·2 joules.

From this, 1kWh = 1·341 horsepower hours, and 1kW = 737·55ft-lb per second.

From these connected figures, 2544·137 × 1·341 = 3411·6877, this number being the number of B.Th.U. equivalent to 1kW.

C. J. MCNAUGHT,
Editor, Textbook Department,
International Correspondence Schools,
London, W.C.2, November 14th.

SIR,—I accept your reviewer's correction to the heat equivalent of a modern kilowatt-hour. I had overlooked that, under nationalisation, not only had there been an overt increase in the price of electricity, but that (under S.R. & O. 1431 : 1949) the Government had also cut down the size of the watt!

This whole argument is, of course, somewhat academic, since the most authoritative recent work on the subject is Griffiths's paper on "The Heat Unit" (*Proc. I.Mech.E.*, Vol. 164, page 215) (THE ENGINEER, April 20th, 1951) wherein it is stated that "At the present time there are several distinct British thermal units in use." Particulars are given of four of these, of which the conversion factor to kilowatt-hour varies from 3409·77 to 3413·13. The particular B.Th.U. about which your reviewer and myself have been arguing is, oddly enough, the only one of the four which is not covered by a B.S.I. Standard.

G. J. WELSH

Rugby, November 15th.

THE SPIRIT OF BRUNEL

SIR,—One cannot deny that the address of the newly elected president of the Institution of Civil Engineers, directed particularly to railway engineers, to emulate the spirit of Brunel is not an urgent call, when we reflect on the plight of British Railways to-day. Indeed, it may be said that this great engineer's spirit has deserted the railways for the more modern forms of transport—roads and aviation. Unfortunately, the spirit of invention and initiative has had no place in our railways for thirty years or more; the predominant quality which prevails among railway employees to-day is a profound knowledge of existing rules and regulations, many of which are obsolete and which stifle progress. In the sphere of railway civil engineering almost nothing of significance has emanated for many years from our own engineers; in fact, until the recent four or five years our railway engineers have lagged behind modern practice.

Since the spirit of Brunel has been banished for so long from our railways, it may be asked if one belated voice in the wilderness can resurrect this noble spirit to its former eminence, to rouse invention and initiative among railway engineers in the British Isles.

W. T. WILKS

Watford, November 19th.

WHITWORTH REGISTER, 1951.

SIR,—A quarter of a century having elapsed since the "Whitworth Book" was published, the Whitworth Society is now engaged in the preparation of a new edition to be known as the *Whitworth Register*, 1951. This is intended to comprise an account of the careers of all Whitworth scholars and exhibitioners from the inception of the scheme by Sir Joseph Whitworth to the present day. The Whitworth awards are regarded by the past beneficiaries as being of continuing value, and it is hoped that, by indicating some of the contributions made to the development of British engineering by former scholars and exhibitioners, the *Register* will be a source of encouragement to the present and future generations. Whilst a large proportion of Whitworth men are in touch with the Society, there remain a number whose present address is unknown, and we wish, through your columns, to invite them to communicate with us, so that we may ensure that particulars inserted against their names in the *Register* shall be as up to date as possible.

S. F. DOREY,
President;
F. T. BARWELL,
Hon. Secretary

The Whitworth Society, Storey's Gate,
Westminster, November 19th.

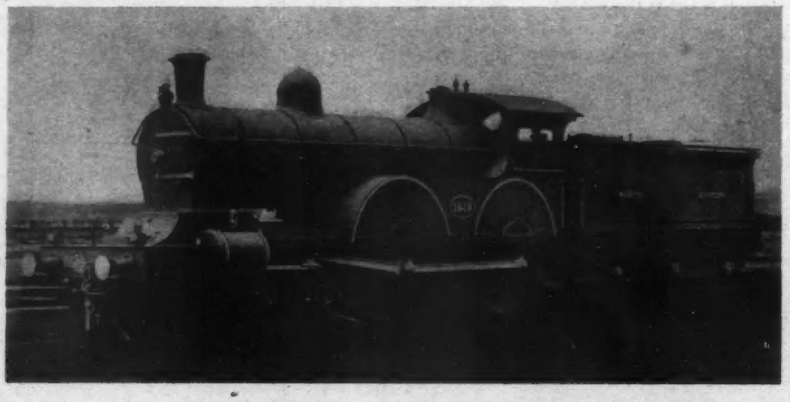
BRITISH RAILWAYS AND WINTER WEATHER.—British Railways has stated that more mechanical aids than ever before will be used this winter. Since early 1949 about 1000 colour light signals and 250 miles of track circuiting have been brought into use so that to-day there are 6000 "searchlight" signals, which penetrate fog, and 6500 miles of the main line routes fitted with track circuiting. The automatic train control system is in operation throughout the Western Region and on the London, Tilbury and Southend Section. A modified form, which can also be used on electrified lines, is now undergoing tests on the main line between Barnet and Huntingdon. For dealing with snow and ice 800 flame guns and 600 steam lances, connected to the engine steam heater pipe, as well as stocks of de-freezing compounds, have now been stationed at strategic points throughout British Railways. Some 550 snow ploughs for "patrol" work or clearing drifts up to 12ft deep are also available. Arrangements have been made with military authorities to afford any assistance necessary in the event of a serious snow blockage in any part of the country. Lines of communication have been strengthened by the opening of seven new telephone exchanges and by improvements in the trunk telephone network, including the extension of carrier wave telephony, which enables several conversations to take place simultaneously over the same line. By arrangement with the Meteorological Office, fifty-one railway control centres are warned in advance when fog, snow or frost (and, in coastal areas, gales) are expected, so that arrangements can be made to meet these conditions; the number of meteorological stations co-operating in this scheme has recently been raised from eleven to fourteen.

Compound Locomotives—1901

By E. C. POULTNEY, O.B.E., M.Inst.Loco.E.

POSSIBLY the most interesting event in the year 1901 was the introduction of compound engines for express passenger traffic on the Midland Railway, for hitherto S. W. Johnson, the locomotive superintendent, had been in the forefront in developing two-cylinder simple expansion locomotives of the usual types, both his four-coupled bogie and single-driver express engines being universally regarded as excellent examples of practice at that period, now half a century ago. The coming of a compound on the Midland was, therefore, considered an event of moment and, moreover, gave practical expression to a statement made by Johnson in the course of his Presidential Address to the Institution of Mechanical Engineers three years earlier, in 1888, when he said that "Every well-considered attempt to increase the economy and power of the locomotive should receive our approbation."

Before looking closely at the Johnson compounds, it is desirable to retrace our steps back to 1898, in which year a compound of an entirely new design intended for express passenger traffic was turned out of the Gateshead works of the North-Eastern Railway. It is, of course, common knowledge that compound engines had been used to a large extent on the North-Eastern for some years. These were the Worsdell-von Borries two-cylinder compounds, originally developed by T. W. Worsdell at Stratford for the Great Eastern Railway and subsequently extensively used, as already mentioned, after Worsdell left Stratford for Gateshead in 1888 on becoming locomotive superintendent of the North-Eastern, a position held with distinction till 1893, when he was succeeded by his brother, Wilson Worsdell. After this change in the direction of affairs at Gateshead, only one two-cylinder compound was built, No. 1618, a large four-coupled engine for express passenger traffic, compounded on the Worsdell-von Borries system, though probably more noteworthy on account of the high steam pressure adopted, namely, 200 lb per square inch, then the highest in the country.



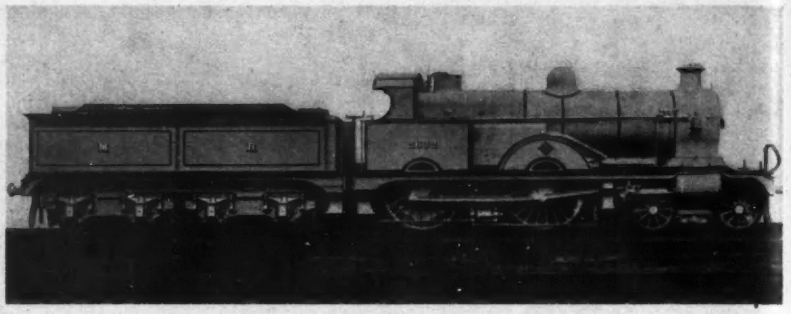
N.E. COMPOUND (SMITH'S SYSTEM)—WORSDELL, 1898

W. Worsdell's compound, like the larger "Single" driver engines built previously at Gateshead, had cylinders 20in and 28in diameter for the h.p. and l.p. respectively, the largest that could be accommodated between the frames, while to use cylinders of this size "outside" was out of the question, due to the restrictions imposed by the standard construction gauge. To get these cylinders between frames spaced 4ft apart inside necessitated having the valve chests outside and inclining the cylinder centre lines in opposite directions, the h.p. upwards and the l.p. downwards towards the centre of the driving axle. This engine was the largest of the two-cylinder compound type possible, due to the limits set on the size of the l.p cylinder. To obtain, therefore, further power, evidently some other cylinder arrangement must be devised.

F. W. Webb at Crewe overcame the difficulty by adopting a three-cylinder system and dividing the h.p. cylinder by using two, placed outside the frames, thus leaving ample space inside the frames for a single l.p. cylinder. Not only did this obviate the difficulty of providing a large l.p. cylinder, but it at the same time got over a further objection present with a two-cylinder system for the reason that it became no longer desirable to equalise the work done between the h.p. and l.p. cylinders, a necessary consideration in the case of two-cylinder compounds. The three-cylinder system adopted by Webb for the L.N.W.R. engines was not, however, the plan he originally proposed, which was to use one h.p. exhausting into two l.p. cylinders, an interesting point in view of the later developments with which we are at present concerned.

W. M. Smith's System

The North-Eastern compound of 1898 was actually W. Worsdell's two-cylinder compound engine No. 1619, entirely rebuilt as a three-cylinder compound on a system devised by W. M. Smith, of the Gateshead works. The cylinder arrangement consisted of one h.p. cylinder between the frames and two l.p. outside the crank pins in the wheel centres being placed at 90 deg. to each other, while the single h.p. crank was arranged at 135 deg. to each of the outer crankpins. The engine was of the 4-4-0 type with 85½in diameter driving wheels and a boiler steam pressure of 200 lb per square inch. The cylinder dimensions were: h.p. cylinder, 19in by 26in; l.p. cylinders, 20in by 24in.; giving a ratio—neglecting clearances—of 1 to 1·91. There were three sets of Stephenson's valve gear between the frames, all six eccentrics being on the single-throw crank axle operating a piston valve below the h.p. cylinder and vertical slide valves inside the frames for the l.p. cylinders. The cylinders, in three castings, were bolted together, and the h.p. exhaust from between the valve heads of the h.p. valve exhausted direct into the adjacent l.p. steam chests without the intervention of any receiver piping.



JOHNSON'S MIDLAND COMPOUND—1901

Beyond the actual cylinder arrangement there was an ingenious steam reducing valve, by which steam could be allowed to pass from the smokebox steam pipe to the l.p. steam chests for starting purposes. This action could be automatic or non-automatic, and the starting steam could be supplied to the l.p. cylinders at different predetermined pressures either at starting or when working compound.

Under the latter conditions the engine was therefore working semi-compound. To permit of the engine being started or operated as a simple compound, two non-return valves were fitted in two pipes connecting the h.p. cylinder ports with the l.p. receiver space. The valves were spring loaded and arranged to open whenever the pressure in the l.p. receiver space exceeded that in the h.p. cylinder. Under such conditions the h.p. piston would have steam of substantially equal pressures on each side, so allowing the l.p. cylinders to exert sufficient tractive force to start the train, or, alternatively, to augment the power of the engine, as required, when running. This, the first Smith three-cylinder compound, ran for a number of years on the old North-Eastern, but was never repeated.

Johnson's Midland Compounds

The first of the celebrated Midland three-cylinder compounds, as designed by S. W. Johnson, consisted of five engines, two built at Derby in 1901 and a further three in 1903. They were constructed on Smith's system and, like the North-Eastern engines, were of the four-coupled bogie type. The cylinder arrangement and also the valve gear was also generally similar, with the important exception that the three sets of Stephenson valve gear had a modified control allowing of the

h.p. and l.p. gears being adjusted for cut-off independently. The cylinder dimensions were h.p., 19in by 26in; l.p., 21in by 26in; giving a ratio of 1 to 2·45, comparing with 1 to 1·91. The h.p. cylinder had a piston valve placed below and the l.p. cylinders vertical unbalanced slide valves. The driving wheels were 84in diameter and the working steam pressure 195 lb per square inch.

When the compounds were built, boilers of the Belpaire type had already been used for Johnson's later four-coupled bogie classes of simple engines, and boilers of the same design were used for the five compounds. They had 1598 square feet of heating surface and a grate area of 26 square feet. Writing in THE ENGINEER of March 25, 1904, Charles Rous-Marten gave an excellent account of the performance of these, the first of the well-known Midland compounds.

More extended particulars are given in the table of dimensions above.

Compound Locomotives, 1901: Principal Dimensions

Railway	N.E.R.	M.R.	L.N.W.R.	
Type	4-4-0	4-4-0	4-4-0	0-8-0
Cylinders, diameter and stroke, inches:				
H.p. cylinders	One, 19×26	One, 19×26	Two, 16 ×24	Two, 16 ×24
L.p. cylinders	Two, 20×24	Two, 21×26	Two, 20½×24	Two, 20½×24
Diameter of driving wheels, inches	85½	84	85	53½
Steam pressure, pounds per square inch	200	195	200	200
Heating surfaces, square feet:				
Tubes	1171·3	1569·8	1328·50	1630
Firebox	118·6	150·0	179·25	123
Total	1323·9	1719·8	1507·75	1753
Grate area, square feet	23·0	26·0	20·5	20·5
Engine weight, tons:				
Weight on coupled wheels	35·5	38·875	37·0	53·5
Total	53·0	59·525	57·6	53·5
Year built	1898	1901	1901	1901

The heating surface given for the N.E.R. engine includes 34 square feet for cross water-tubes fitted in the firebox increasing the heating surface from 118·6 to 152·6 square feet. H.p. cylinders for L.N.W.R. 4-4-0 engines subsequently reduced to 15in diameter, thus increasing the h.p./l.p. cylinder volume ratio to 1 : 1·86 from 1 : 1·63 originally.

Special Trials

A series of trials was made with one of the first engines built, No. 2631, between Leeds and Carlisle, 113 miles.

On the down journey with trains of from 149·6 to 168·8 tons behind the tender at average speeds varying between 47·7 and 48 m.p.h., the coal consumption per gross ton-mile was 0·127 lb to 0·135 lb, the corresponding water consumptions being 1·093 lb and 1·068 lb. The evaporation varied from 8·6 lb to 8·0 lb per pound of coal fired.

These results apply to 149·6-ton and 168·8-ton trains.

In the opposite direction from Carlisle with one test train of 178·8 tons, the speed averaged 49·1 m.p.h. and the coal and water consumptions per gross ton-mile came out at 0·08 lb and 0·832 lb respectively, the evaporation being 10·4 lb per pound of coal fired. The actual speed of 49·1 m.p.h. and the coal consumption per mile of 23·4 lb would seem to correspond to an evaporation of 11,950 lb and a firing rate of 1147 lb of coal per hour, the total heating surface, all evaporative, being 1598 square feet, and the area of the grate 26·0 square feet; the evaporation therefore equalled 7·5 lb per square foot of heating surface and the rate of firing 44·2 lb of coal per square foot of grate area per hour.

During these trials a number of indicator diagrams were taken at different speeds in miles per hour. The following are some of the powers developed:—

Speeds, miles per hour	I.h.p.
20	600
42	1000
50	980
60	940
78	780

If the powers shown are plotted against speeds the rate of power loss with increasing speeds is clearly seen. The maximum cylinder power is shown at 42 m.p.h., 168 r.p.m., and the minimum of 780 i.h.p. at 78 m.p.h., corresponding to 312 r.p.m. The fall in cylinder power with increasing speeds is characteristic of the steam locomotive and is principally due to inadequate port openings, caused by the valve gears normally used. In the case of the engine under notice, this drop in power, though noticeable, is not excessive, probably on account of the large driving wheels, which, by keeping down the revolutions per minute, would reduce throttling tendencies.

Webb's Four-Cylinder Compounds

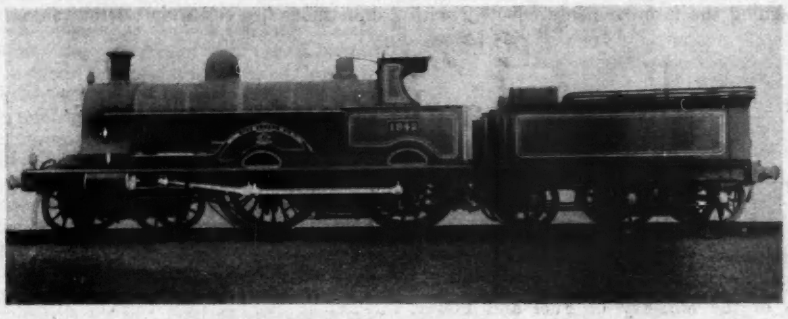
In THE ENGINEER of July 25, 1947, will be found a contribution by the writer on F. W. Webb's first four-cylinder compound engines for express passenger traffic on the L.N.W.R. There were forty of them, followed by an enlarged series of substantially the same design, the first of which came out in 1901. These were known as the "1941" or "Alfred the Great" class, as illustrated. They differed from the earlier engines on account of having rather larger boilers and larger h.p. cylinders, 16in diameter, as against 15in. The l.p. cylinders remained as before at 20½in diameter, which, with the increased size of the h.p. cylinders, reduced the cylinder ratio to about 1 to 1·63. This proved unsuitable and resulted in the h.p. cylinders being restored to their original diameter of 15in, so bringing the ratio of volume back to the original figure of 1 to 1·86.

The larger boilers for these engines had a total heating surface of 1507·5 square feet, comparing with 1400·4 for the earlier class; the grate area, however, remained 20·5 square feet as before. The valve gear arrangement was exactly as fitted to the "Jubilee" class, and the coupled wheels had the same diameter of 85in, while the boiler pressure was also the same, namely, 200 lb per square inch. Unfortunately, though engines of this design had certain good features, they were not really a success. The cylinder ratio was, it is considered, mainly responsible for somewhat inferior performance. The idea of using two sets of valve gear for the four valves was, of course, a simplification compared with the French De Glehn system, but its use would seem to dictate radically different cylinder volume ratios for satisfactory results.

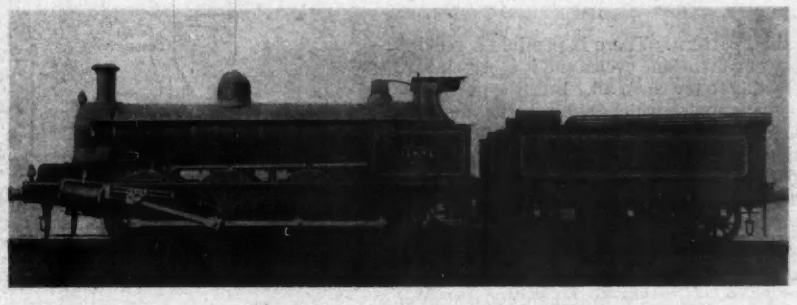
Webb's Compound Freight Engines

The year 1901 saw also a new design of eight coupled compound freight engine, built at Crewe from Webb's designs. Like the latest passenger engines, they also had four cylinders of the same dimensions and arranged in the same manner at the front of the engine and driving on the one axle. The new locomotives were generally based on the three-cylinder compounds of the eight coupled type, first built in 1893, but the boilers were larger, with 1753 square feet of heating surface, comparing with 1489 square feet. The working steam pressure was also raised from 175 lb to 200 lb per square inch. The eight coupled wheels were 53½in diameter on an equally spaced wheel base and, like Webb's other freight engines, having the same sized wheels, the wheel centres being, as before, of cast iron.

The "Alfreds" and the eight coupled freight engines of 1901 were, with the exception of some four-cylinder compounds of



L.N.W.R. FOUR CYLINDER COMPOUND—WEBB, 1901



L.N.W.R. FOUR CYLINDER COMPOUND FREIGHT—WEBB, 1901

the 4-6-0 type, introduced in 1903 and intended for mixed traffic, the last designed by F. W. Webb before his retirement in the same year.

Thus was brought to a close an era in the long history of locomotive development and the largest application of the compound principle to locomotives ever before or since undertaken by a single railway system.

Whale's Experiments

Though strictly outside the compass of this article, reference may fittingly be made to an experiment carried out by G. Whale (who succeeded F. W. Webb at Crewe) with some of the four-cylinder compounds of the "Alfred the Great" class. Mention has already been made of the deficiency of these engines in the cylinder ratios. In order to overcome this, two additional sets of Joy's valve gear were applied to the outside pair of h.p. cylinders and a type of reversing control fitted, somewhat on the lines of that used years earlier, in 1884, when the three-cylinder "Dreadnought" express engines were first built by Webb. By its use in conjunction with the four sets of valve gear, the h.p. gear could be notched up independently of the l.p. gears, an arrangement which materially improved the performance of these engines.

Very interesting and complete information concerning the improvements effected, with reproduced indicator diagrams, was given in The Engineer of January 8, 1904. Briefly, trial runs were made between Crewe and Stafford with trains of equal weight hauled by engines of the "Alfred" class as originally built without the duplex valve gears and with this modification.

Weight of train, including dynamometer car, not including locomotive, 372 tons.

Engine as Originally Built

Time, Crewe to Stafford	38½ min
Average speed	37·79 m.p.h.
Maximum i.h.p.	814·81
Time, Stafford to Crewe	34 min
Average speed	42·79 m.p.h.
Maximum i.h.p.	756

Engine as Altered with Duplex Valve Gear

Time, Crewe to Stafford	33 min
Average speed	44 m.p.h.
Maximum i.h.p.	940·0
Time, Stafford to Crewe	30 min
Average speed	48·5 m.p.h.
Maximum i.h.p.	949·2

After being fitted with the Duplex valve gear arrangement, one of the engines, No. 1941, "Alfred the Great," made an excellent run from Rugby to Willesden, start to stop, in 85·7 min with a heavy train of 465 tons, averaging a speed of 54 m.p.h. for the 77·2 miles.

Starting from Rugby to passing Tring took 59·46 min for the 50·9 miles, representing an average of 51·3 m.p.h. Particulars of this run were given by Charles Rous-Marten in The Engineer, December 9, 1904, and for a locomotive of such moderate dimensions this is without doubt a fine effort.

Some Fuel and Power Projects*

By H. ROXBEE COX, Ph.D., B.Sc. (Eng.), M.I.Mech.E.†

No. I

Preamble

THE work in progress which I intend to describe is the research and development work of the Ministry of Fuel and Power. It is the first description of this work with any pretension to completeness, a not surprising fact as the Chief Scientist's Division has been in existence only three years, and for the first year was little more than an embryo This work is to a pattern. Parts of the pattern can be filled in with detail. Other parts are still in outline. Despite this variability of texture, I hope that a coherent picture will emerge.

The Use of Solid Coal

The coal-consuming gas turbine projects of the Ministry conform to an obvious, but

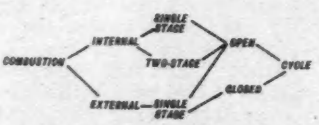


FIG. 1—*Variables Represented in Ministry of Fuel and Power Coal-Burning Gas Turbine Projects*

desirable, pattern. There is possible a great variety of gas turbine cycles and it is certainly not feasible to try them all. But it is possible to try examples which exhibit the major variables, and we have envisaged our coal-burning turbine plan as standing on four "legs."

The major variables we have chosen are the obvious ones and are indicated in Fig. 1. The four "legs" are crossed by the dotted line, defining our coal-burning gas turbine projects as: the open-cycle, single-stage internal combustion gas turbine; the open-cycle, two-stage internal combustion gas turbine; the open-cycle, single-stage external combustion gas turbine, and the closed-cycle, single-stage external combustion gas turbine.

Open-Cycle, Internal Combustion Coal-Burning Gas Turbine.—Towards the achievement of this project, work has proceeded along three lines which might be described as large-scale laboratory combustion experiment, running of an adapted experimental engine, and design and construction of an engine for development purposes.

The laboratory work has been done under the auspices of the Department of Scientific and Industrial Research at the Fuel Research Station, Greenwich, and at the British Coal Utilisation Research Association, Leatherhead. At the former place, Mr. Hurley has tested two kinds of "dry" combustion chamber (Roxbee Cox, 1950; Hurley, 1951). One is a tubular "straight-through" chamber employing his multi-grid burner and the other is a vortex chamber. These experimental chambers successfully burn pulverised coal at 500 lb per hour. In both of them the air flow is arranged so that combustion of the particles takes place while

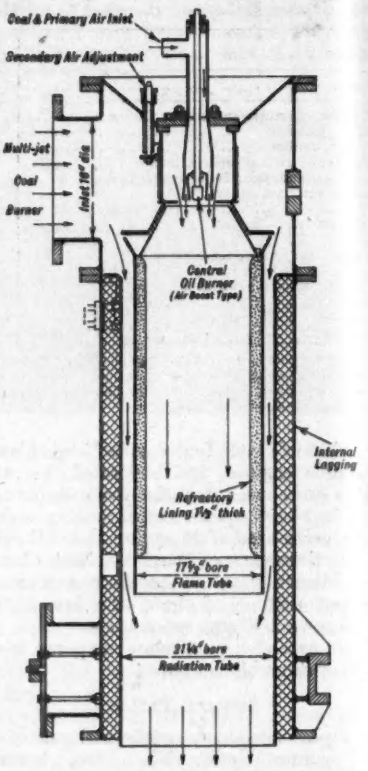


FIG. 3—*Coal-Burning Combustion Chamber for Parsons 500 h.p. Experimental Engine*

they are in suspension. When chambers of these kinds are used with gas turbines, the ash is separated from the products of combustion in a dry state.

At Leatherhead, Mr. Battcock has worked on a "wet" combustion chamber—that is to say, one in which the flow is arranged so that combustion largely takes place on the walls of the chamber where the ash remains behind in a molten state and is withdrawn

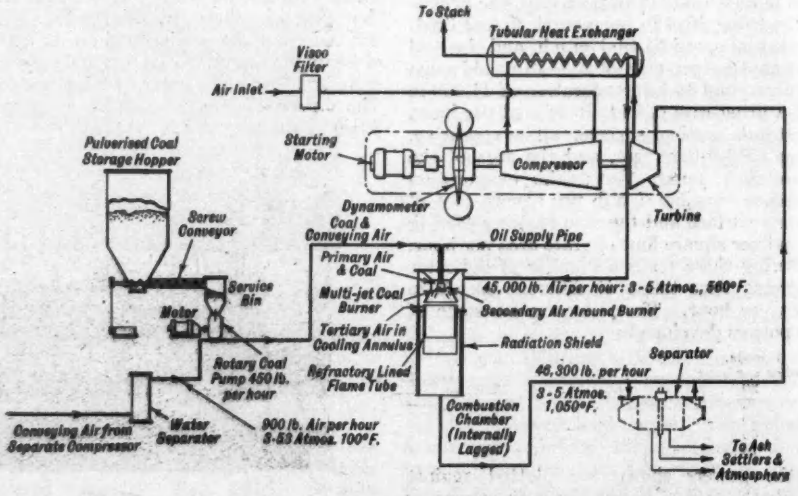


FIG. 2—*Coal-Burning Version of Parsons 500 h.p. Open-Cycle Experimental Gas Turbine*

* Institution of Mechanical Engineers. Thomas Hawksley Lecture, Abstract. November 16th.

† Chief Scientist, Ministry of Fuel and Power.

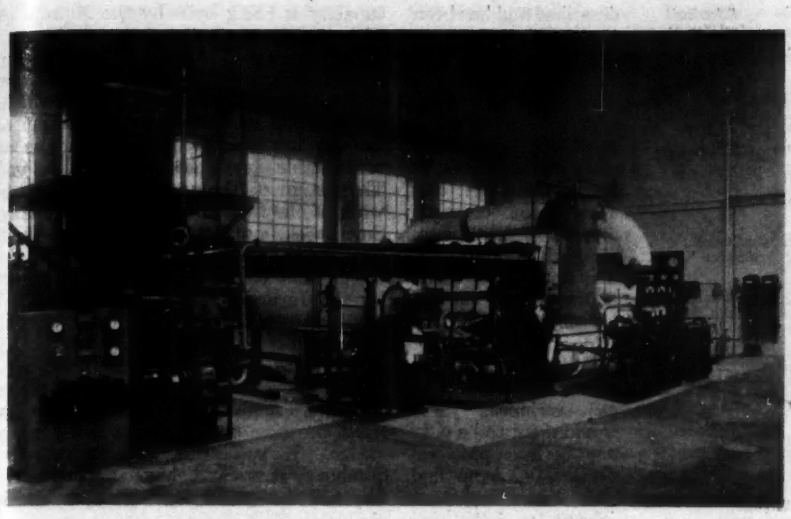


FIG. 4—*Coal-Burning Version of Parsons 500 h.p. Open-Cycle Experimental Gas Turbine*

in a "wet" condition. This is the so-called "cyclone" chamber; it is also referred to as a "slagging" chamber (Roxbee Cox, 1950; Karthauser, Battcock, and Ross, 1948).

The "running of an adapted experimental engine" to which I have referred has, in fact, been a far more complex operation than these words indicate. The engine in question is the 500 h.p. open-cycle gas turbine belonging to C. A. Parsons and Co., Ltd. The coal-burning work in connection with it has been done by that company under direct contract to the Ministry. It was first necessary to develop a combustion chamber, and a version (Fig. 3) of the straight-through tubular type already described was chosen. It was also essential to have adequate means of cleaning the products of combustion before they passed through the turbine, and a satisfactory means of pumping the fuel into the combustion chamber. The difficulties to be overcome before these essential components could be integrated into a satisfactory whole with the engine were of the character common to all development work and call for no special comment. The satisfactory stage has been reached at which the engine which first ran on coal, without the cleaners, on February 14, 1951, is running successfully on fuel of which 80 per cent passes through a 200 B.S. mesh sieve.‡ The arrangement of the cycle is shown diagrammatically in Fig. 2, and the whole plant is shown in Fig. 4. The coal storage and feeding arrangements are prominent on the left of Fig. 4, and the vertical feature on the right is the combustion chamber, standing on the "Siroco" dust collector.

The design and construction of a gas turbine plant planned from the outset as a coal-burning engine has been in the hands of the English Electric Company, Ltd. This plant is of 2000kW capacity. The rotating parts are of normal design. The cycle diagram is in Fig. 5*a* and the corresponding parts will be identified in Fig. 5*b*. The design of the cyclone slagging type of combustion chamber is shown in Fig. 6.

‡ With this fineness, the distribution of particle size is such that about 95 per cent passes through a 100 B.S. mesh sieve, and 99·5 per cent through a 60 B.S. mesh sieve.

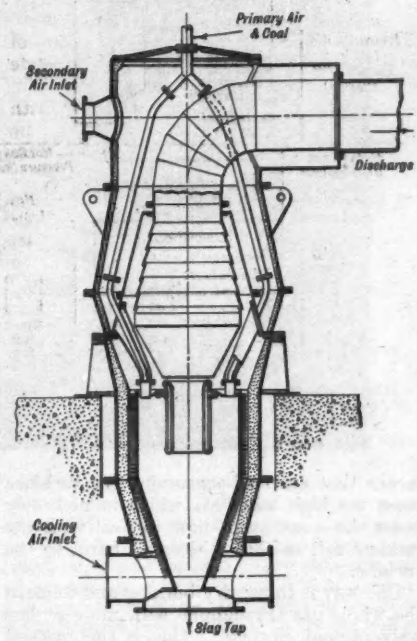


FIG. 6—*Cyclone Slagging Combustion Chamber for 2000kW English Electric Coal-Burning Gas Turbine Set*

A very compact plate type heat exchanger, manufactured to English Electric design by Joseph Sankey and Sons, Ltd., of Bilston, has been embodied. The thermal ratio is 65 per cent. The way the plates are arranged in this heat exchanger, which measures roughly 6ft by 5·5ft by 4·5ft, is shown in Fig. 7. Both the combustion chamber and the heat exchanger are prominent features in Fig. 5*a* and *b*.

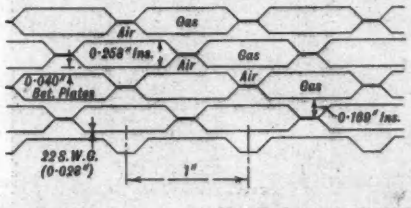


FIG. 7—*Plate Arrangement in Heat Exchanger for 2000kW English Electric Coal-Burning Gas Turbine Set*

The leading particulars of the plant are shown in Fig. 5*a*. After extended running on the test bed, due to begin in 1952, it is intended to use this engine as a piece of industrial equipment.

Open-Cycle, Two-Stage Internal Combustion Coal-Consuming Gas Turbine.—In all our work on fresh means for using coal, the aim is to develop machines which do not need to discriminate in the coals they use. This

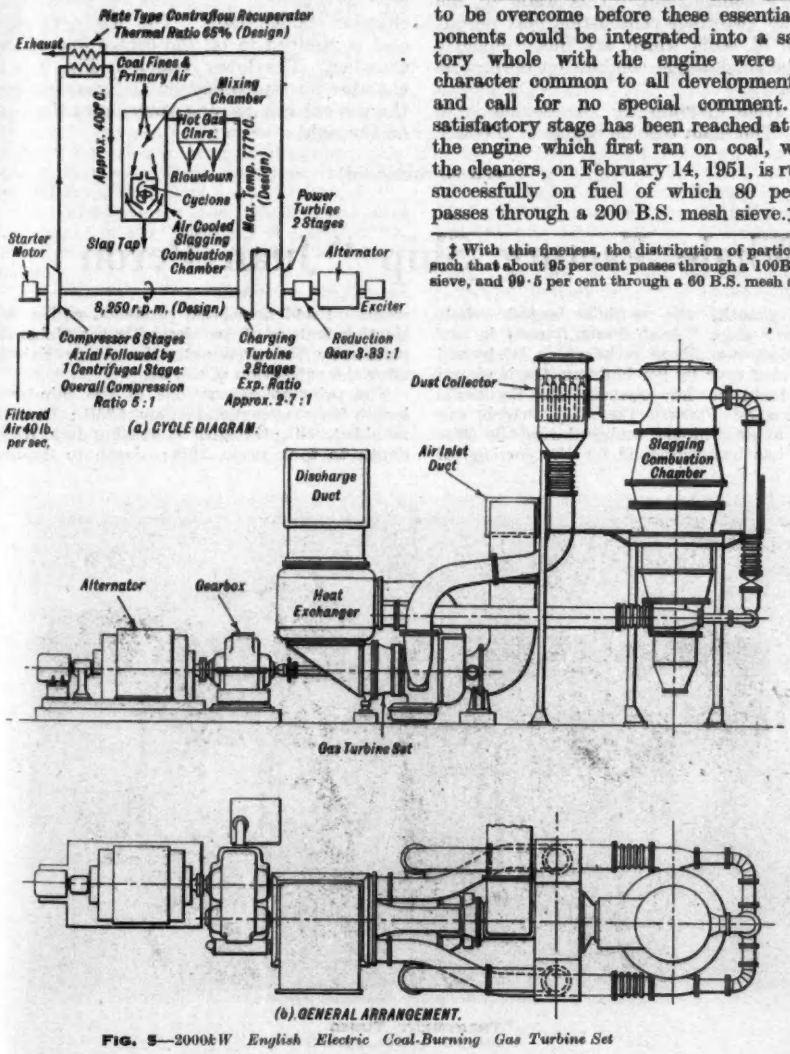


FIG. 5—2000kW *English Electric Coal-Burning Gas Turbine Set*

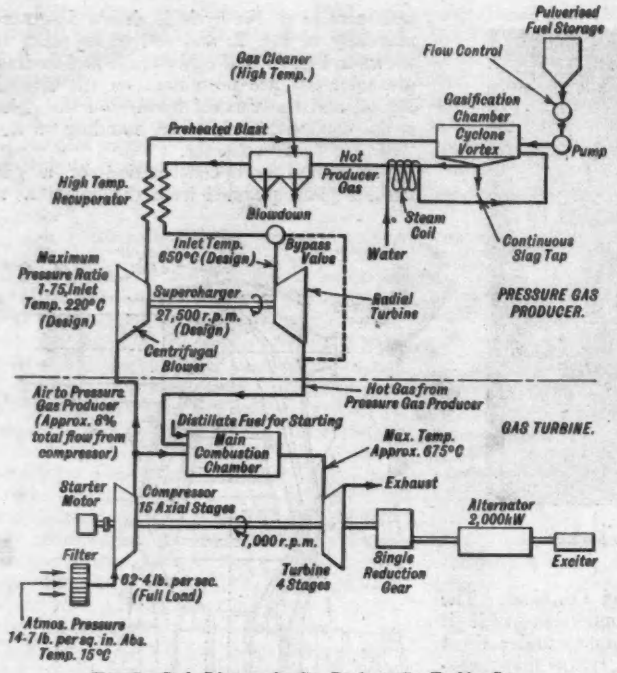


FIG. 8—*Cycle Diagram for Gas Producer Gas Turbine Set*

means that our coal-consuming gas turbines must use high ash fuels, which immediately poses the question of how to deal with the residual ash so that it does no harm to the turbine.

One way is to use dry burning and to clean the whole gas throughput with more or less conventional cleaners. This is the method adopted in the Parsons engine. Here the problem is to clean down to a size of dust particle which will not abrade the turbine blades—a double problem, because in addition to finding how best to clean to a given size, there is the problem of what size to clean to. Opinion is still divided on the critical magnitude, varying from 5 to 20 microns.

Another method is to use a slagging combustion chamber (Fig. 6) and to withdraw most of the ash as molten slag. This method of getting rid of the ash is that adopted in the English Electric engine just described and has been the subject of recent experiment by John Brown and Co., Ltd. The gas may require further cleaning, depending upon the size of particle which is carried through, and a conclusion on what is the critical size. This additional cleaning could be done before or after the gas is mixed with the diluent air.

So long as we stick to internal combustion gas turbines, there would seem to be only one other practical possibility, a method which is an important advantage of the kind of engine to be described in this section. By arranging the combustion in two stages, with the first stage producing combustible gas and the second stage its combustion, cleaning may be confined to the first or gasification stage. In the particular engine on which work is in hand, this means that only about 10 per cent of the throughput has to be cleaned (compared with about 40 per cent with the slagging chamber and 100 per cent with dry combustion). This leads to the hope that two-stage combustion may permit the use of coals which are inconveniently dirty for single-stage combustion open-cycle engines.

The cycle diagram for the engine is in Fig. 8. The main turbine engine of 2000kW capacity is being built by the Metropolitan-Vickers Electrical Company, Ltd., and is due to be ready in May, 1952. The supercharging turbo-compressor is also being provided by this company and it will have considerable interest in its own right as it has an inward flow (radial) turbine with controllable incidence entry guide vanes. The design of the gas producer is the joint work of the Incandescent Heat Company, of Smethwick, and Joseph Lucas (Gas Turbine Equipment), Ltd., of Burnley. The detail design and construction of the producer is by the Incandescent Heat Company. The particulars of the full-scale plant, which it is hoped will operate in 1952, are shown in Fig. 8.

The working pressure of the gas producer will be about 6 atmospheres and no producer heretofore made in Great Britain has had a super-pressure of more than a few inches of water. If successful, the pressurised gas producer may well have applications far beyond the plant for which it has been designed.

As it is so novel a venture, that we have decided not to make the producer without trying a pilot scale producer first is not surprising. This pilot scale plant, which has an air throughput of 1 lb per second, is shown in Fig. 9 on the test rig at the Burnley works of Joseph Lucas, where it has been running since September, 1951.

The gasification chamber, which works at 6 atmospheres, is of the cyclone-vortex type and is designed to run under slagging conditions. The main air supply, which is preheated in a paraffin heater designed for the test rig work, passes through the tripod pipe arrangement and enters the gasification chamber tangentially. The finely divided coal is pumped in on the centre line of the chamber. The lower vessel in Fig. 9 is a chamber for slag collection and gas cleaning, the gas exhaust passing away down the pipe on the right.

(To be continued)

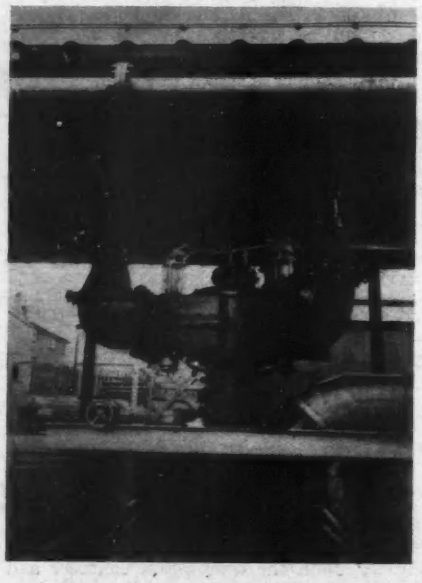
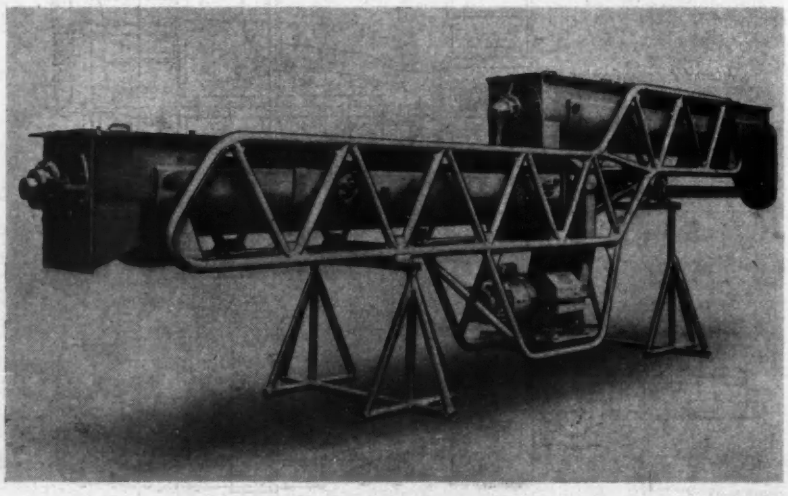


FIG. 9—*Pilot Gas Producer for Producer Gas Turbine Development*

Whale Factory Ship "Juan Peron"

LAST month, the world's largest whale factory ship, "Juan Peron," seen in our illustration, completed satisfactory trials and was handed over by her builders, Harland and Wolff, Ltd., to her owners, the Compania Argentina de Pesca. The ship, which can operate as an ordinary tanker during the close season, has been designed for the carriage of whale oil and associated products, and a distinctive feature of her design is the elaborate machinery for processing the whale residue after the extraction of the oil.

The principal dimensions of the ship are: length between perpendiculars, 635ft; breadth moulded, 80ft; breadth at flensing deck, 80ft; depth to tank deck, 36ft; depth to flensing



TREATMENT TUBES

deck, 61ft; mean summer draught, 34ft 7¼in; and deadweight, 25,324 tons. She is equipped to comply with the requirements of the Argentine authorities, the British Ministry of Transport, the Suez and Panama Canal regulations, and the requirements of the British Factory Acts.

Built under Lloyd's special survey, the ship is of two-deck design and embodies the usual features associated with whale factory ships. The flensing deck is 323ft long by 80ft wide and the steam deck machinery includes two fishing winches, two 40-ton winches for hauling the whales up the skidway and two capstans for handling special grab hooks, which are fastened to the carcase before hauling. There are ten capstans, fourteen derricks worked by sixteen 5-ton winches, and a 15-ton winch for handling carcases in the flensing deck. In the factory, which is 358ft long by the full width of the ship, is the whale oil producing plant, consisting of Kvaerner rotating whaling apparatus, press boilers, separators, and meat meal and liver oil extraction plant.

Accommodation has been provided for a total complement of 484, consisting of a crew of 92, catcher crews numbering 136, and 256 factory workers.

The main propelling machinery consists of two Harland-Burmeister and Wain single-acting, four-cycle, diesel engines, each having six cylinders of 740mm diameter by 1500mm stroke and developing the necessary power at 110 r.p.m. Steam for the auxiliaries and process work is supplied by six single-ended cylindrical multitubular boilers, burning oil fuel under forced draught. In addition to the usual auxiliaries, there are three evaporating and distilling plants, each capable of producing 250 tons of fresh water per day.

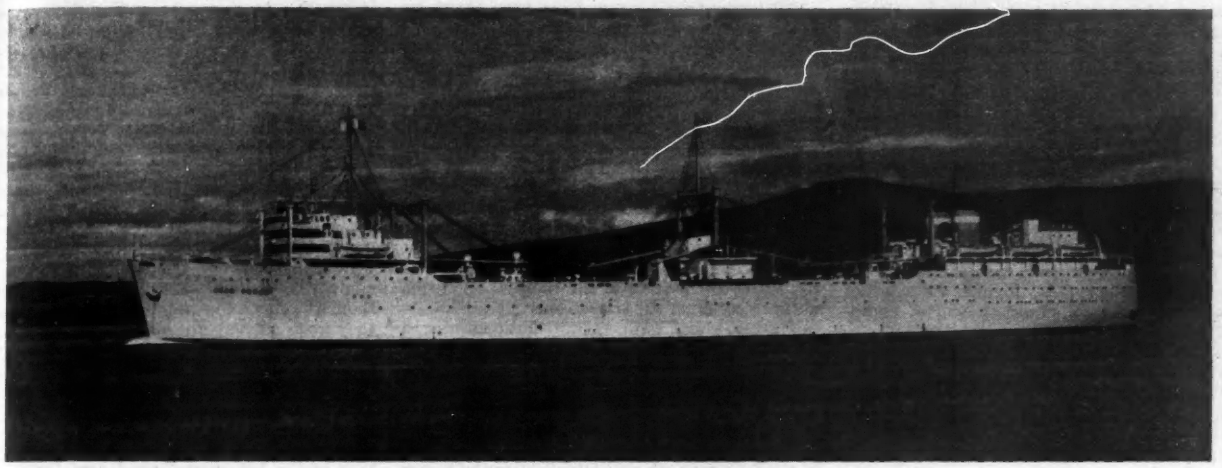
A total of 345 electric motors is installed in the ship, ranging from ⅛ h.p. to 135 h.p. and having a total connected load of about 2107kW, of which 1520kW is required to drive the electrically operated factory machinery. To meet the load, the installed generating plant consists of five 425kW, 220V, d.c. generators, each driven by a single-acting, four-cycle, Harland and Wolff diesel engine having six cylinders of 380mm diameter by 570mm stroke, one 120kW, 110V, d.c. diesel-driven generator, and one 120kW, 110V, d.c., motor generator for lighting.

The "Juan Peron" is allowed to catch a maximum of twenty blue whale units per day, and the prevailing shortage of oils and fats makes it essential for the economic efficiency of the ship that the equipment will extract the maximum of these commodities, especially liver oils and high protein feeding meals. A total of 2500 tons of raw material can be handled per day, including 320 tons of lean meat, 200 tons of grax, and 15 tons of raw liver. To deal with the residual solids and entrained liquors from the blubber and fat meat sections, which are known as grax, the lean meat and the livers, Rose, Downs and Thompson, Ltd., of Hull, have designed and supplied special machinery.

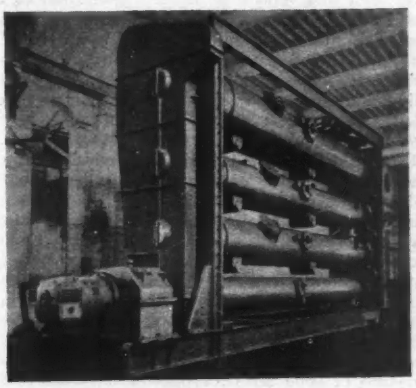
The grax plant reclaims valuable oil and incorporates special screens which remove most of the free liquor before the material is passed into the low-pressure liquor expellers, in which the raw material is continuously and automatically compressed by double screws in two successive cages to extract the liquor. The liquor thus obtained is screened and the oil content is reclaimed by centrifugal separation and purification, together with the oils from the blubber and fat meat.

A feeding meal which contains a minimum of oil and a high digestible protein content is produced by the lean meat plant, which includes equipment for preliminary reduction and oil separation, sterilising and drying, cooling, grinding and bagging. The reduction is carried out in hoggers, which pulp the material and so facilitate oil expression. Harpoon shrapnel and tramp iron from the flensing deck are removed by magnetic belts. After cooking in special treatment tubes, illustrated on page 666, the reduced meal is fed to vibratory screens and low-pressure expellers, where oil, blood, lymph and water are removed, and the oil reclaimed. After sterilisation the solid residue is dried in vacuum drier units and then passed through cooling tubes. The cooled meal is passed over magnetic belts and then forwarded to the grinder and cyclone unit before bagging.

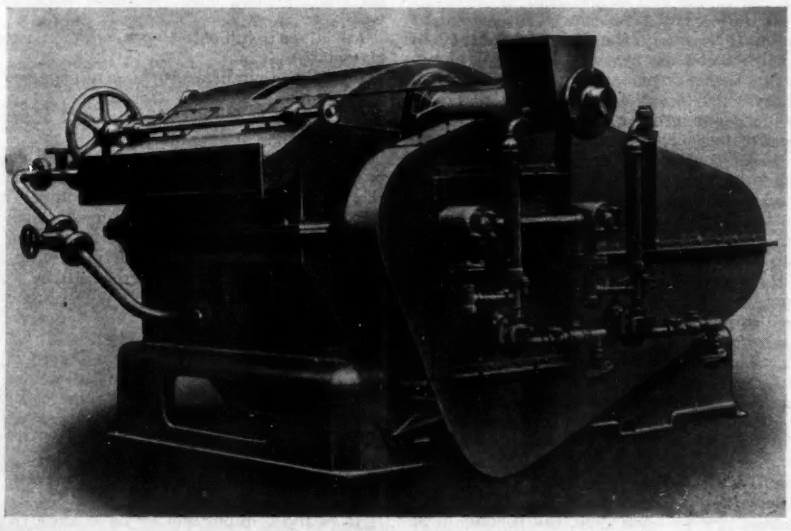
The liver oils which have a high vitamin "A" potency, are recovered by solvent extraction and the residuals form a feeding meal with a high riboflavine content. Before extracting the oil the raw liver is minced, a form of flake is prepared and the moisture content lowered. Flaking is carried out in a coagulating chamber, illustrated herewith, and the drying and cooling, in a horizontal tube unit. Using trichlorethylene as a solvent, the extraction plant removes the oil from the dried and cooled liver flakes and the solvent is recovered by distillation; the hydrochloric acid formed when reclaiming the solvent must be neutralised. The liver oil is filtered and stored in drums, while the extracted meal is dried, cooled and bagged.



WHALE FACTORY SHIP "JUAN PERON"



HORIZONTAL TUBE UNIT



COAGULATING CHAMBER

Measurement and the Power Transmission System*

By F. J. LANE, O.B.E., M.Sc., M.I.E.E.†

Measurement in Research

I CANNOT make more than a passing reference to measurement in research, since to do anything like justice to the ingenious and careful work which has formed a background to our modern transmission systems, an entirely separate address would be necessary. It will be sufficient to remind you of such investigations as those on the effect of atmospheric conditions on insulators and overhead line conductors, the measurement of corona levels and radio interference, the determination of the characteristic impedances and losses of lines and cables, and the exploration of the noise problem with transformers, to indicate the contribution that has been and is being made by research towards the achievement of the present high standard of security in supply channels.

It is clear, however, that with the expansion of supply systems, the higher voltages of transmission, and the closer control of equipment design which will be necessary to keep down capital costs, the scope of research must likewise be expanded if the measurements involved are to be really valid for practical networks. For example, the increasing need for the transmission of large blocks of power over great distances or in circumstances where the overhead line is not a desirable or practicable solution is inevitably causing supply engineers to look at the possibility of using d.c. transmission. As I understand the situation, however, the facts are that, although research has produced solutions on small-scale equipment and at low powers at voltages up to 50kV, and has indicated to a limited extent the way in which the problems of rectification and conversion, switching and protection can be solved at high voltages and large powers, there cannot be sufficient assurance of practicability until there is a painstaking attempt at a major d.c. transmission project. Such a project must be expensive and would make serious demands on technical manpower and works production capacity at a time when money, manpower and works capacity are all in short supply. The time required to produce results would be of the order of five to ten years, and so long as this gap remains it is evident that, while we live under an economy in which construction lags well behind need, the practical solution of any supply circuit problem must be an a.c. one. It may be, of course, that such a research project would show that extrapolation from present data is far from accurate, but until the problem is tackled no one can be certain, and the possible advantages of asynchronous interconnection and the wider markets for power cables and convertors will continue to tantalise the manufacturer and the transmission engineer.

[Mr. Lane then discussed the subject of measurement in design, including the significance of type tests for proving a design and routine and sample tests for checking uniformity of production.]

Measurement in Operation

The functions of measurement equipment on the transmission system in operation are to facilitate utilisation of the equipment with the maximum economy, to assist in the detection of weaknesses before breakdown occurs, and to provide means for analysing the conditions consequent on breakdown.

The ammeter, by indicating the actual current in the circuit, also, by relation to the rated current of the circuit, indicates the thermal margin available between the operating condition and the full-load condition. This was quite satisfactory when circuits were fairly simple units—switchgear and cables—and full-load operation was rare. In present days, however, circuits may include switchgear, transformers, cables and overhead lines, each item having a different thermal characteristic and rating. Further, with the present shortage of transmission equipment in relation to load, a much more accurate knowledge of thermal ratings is desirable, and it is necessary to consider whether the magnitude of the current is a satisfactory criterion of the ability of a circuit to carry load. The latest practice on transformers suggests that a better guide is the temperature.

All larger transformers have been fitted for years past with thermometers for indicating oil temperatures and possibly winding temperatures. These have frequently been provided with contacts suitable for automatic control of cooler pumps and fans or for giving alarm and trip signals. It was soon found, however, that it was not possible to obtain the correct relation between cooler operation and the alarm and trip signals if these functions were separately allocated to the oil thermometer and the winding thermometer. Present practice on new grid transformers requires the provision of duplicate winding thermometers to give better control of the thermal operation and protection of the transformer.

The winding temperature indicator is a capillary thermometer with its bulb in an oil pocket on the top of the transformer. A heater strip round the pocket or the bulb is energised from a current transformer in one of the phases. In theory the characteristics of the current transformer and heater and the location of the bulb are such that the effect of the heater added to the top oil temperature reproduces the temperature in the hottest part of the winding. In practice the heater may be unsuitably located in relation to the thermometer bulb, its time constant may be different from that of the winding, and the accuracy of the thermometer may be poor. Only within the last few years has the design of these "thermal images" received serious attention, and the older types are highly suspect. This state of affairs makes it difficult to apply the theory that a transformer should be loaded according to its temperature. When one considers, however, that the British Standard design is based on a mean ambient temperature of 35 deg. Cent., and that in general the peak loads occur in winter and are of relatively short duration, it is clear that the margin of load transfer security can be reduced at points of supply and that transformer reinforcements can be postponed if full advantage is taken of the thermal capacity. General calculations, based on an average daily load cycle, indicate that it should be safe in emergency to operate transformers in conditions where the peak demand exceeds the rated capacity by some 30 per cent. The adoption of such a basis of operation, however, presupposes that steps are taken to improve greatly the reliability of the winding temperature devices.

In this connection, a further improvement would be the provision of a winding temperature dial on the control panel where the attendant can see it. Normally, the scale and contacts of the thermometer are mounted in a kiosk alongside the transformer, and operation through capillary tube is satisfactory up to distances of 200ft. For greater distances some other method of measuring temperature is necessary. The thermocouple has too low an output for satisfactory operation on transformers. One method successfully uses a platinum resistor mounted in the oil pocket and heated by winding current as described above, with an auxiliary supply so connected that the current through the thermometer resistor and the current through a fixed resistor are compared in a crossed-coil instrument.

The transformer is not the only item of equipment which, in British climatic and loading conditions, could be overloaded by normal standards, and the abnormal circumstances of our day will compel us to take risks which would have been unacceptable a dozen years ago.

The British 132kV grid system, which has been operated successfully as a fully interconnected system since 1939, has become more and more dependent on centralised measurement of supply quantities as operating technique has improved. There are now eight area control rooms, each responsible for the detailed operation of the system in its own part of the country, and one national control room responsible for co-ordination of the area controls and inter-area transfers. The whole of the area control operations is effected by means of hired Post Office communication channels and telephone type equipment, much of which is twenty years old. The equipment is becoming impossible to maintain and highly expensive to extend. It has therefore been decided to replace all the old control room equipment during the next five to eight years, and the following is a brief description of the instrumentation to be adopted.

The "sent-out" active power and reactive power of each generating station of over 20MW capacity will be transmitted to and indicated on a "loading desk" at the control room for that area. The initiating meters will be the rotating meters provided for tariff purposes. These will impulse to the usual summator, which, in turn, will transmit impulses to area control on a Post Office line. At the control room the incoming impulses will be converted to direct current to energise a milliameter, which will act as the generated load indicator for the corresponding generating station. Summation of the direct currents will give total area generation for transmission to national control.

On the loading desk, also, there will be indication of the net inter-control area transfers of active and of reactive power. Associated with each generating station and inter-area meter will be an instruction device, so that the area control will be able to see immediately what was the last instruction given, what is the present response, and, by means of an additional hand-set pointer, the available generating plant.

On a loading wall-diagram, feeder flow will be displayed in terms of "MW" and "MVar" on the more important lines or transformer feeders from the large generating stations.

The initiating devices for all these indications will be rotating meters—tariff type meters for generation as mentioned above, and single-phase meters with three-point commutator contacts for feeder flow. The feeder flow meters will rotate in either direction according to the direction of load transfer, the three-point contact arrangement permitting "import" or "export" to be determined from the one meter.

The time taken by the indicating devices to follow the variations of the transmitted quantity will vary with the impulsing frequencies of the initiating meters, which differ appreciably among the different designs. A typical example is that for stations where the generator meters transmit at least twelve impulses per minute for generator full load, and where the summator transmits between 24 and 66⅔ impulses per minute for full load on the station; the telemeter performance will be:

(*a*) 50 sec to indicate 50 per cent of generation change.

(*b*) 75 sec to indicate 80 per cent of generation change.

(*c*) 120 sec to indicate 100 per cent of generation change.

(*d*) 30 sec delayed response to gradual change.

Frequency indication will be given from not more than five points in the control area. The initiating device will be a newly developed rotating frequency meter with a straight line impulsing characteristic starting with zero impulses at 45 c/s. The error will be within ±0·1 c/s under mains supply conditions varying between 44 c/s and 52 c/s and between 180V and 260V.

Standard time, frequency time, rate of frequency change and time-error indications will be provided in each control room. Except for the standard-time indicator, these will be energised from a local mains supply with a back-up supply locally generated, but controlled by system frequency signalled over a private wire from a suitable grid station.

It is most important to have such records as will permit day-to-day conditions and any

* Abstract. Chairman's Address, Measurements Section, Institution of Electrical Engineers, London., October 23rd.

† British Electricity Authority.

emergency conditions to be analysed, and for these purposes a continuous record has definite advantages over logged readings.

The following quantities will therefore be recorded :—

(1) Any one of not more than five system voltage telemeter indications.
(2) Any one of the frequency telemeter indications.
(3) System frequency.
(4) Rate of frequency change.
(5) Time error.
(6) MW net inter-area transfer.
(7) MVar net inter-area transfer.
(8) MW total generation.
(9) MW total load for the area, if practicable.

Two designs of pen-type recorder are favoured —one with the chart driven by seven-day hand-wound spring and balance-wheel escapement, and the other driven by a synchronous motor connected to the mains. The first has the advantage that it is independent of mains timekeeping or mains failure. The charts of both types are small and not always linear, and the time ordinate may be radiused to suit the instrument movement.

A more accurate type of instrument is the wide-scale, slide-wire potentiometer-type recorder. This has a 10in scale with straight-line ordinates and has been found satisfactory down to 10mV or 20mV for full-scale deflection. The instrument is very suitable for the direct summation of a number of total generation telemeters, but it is expensive and heavy and is dependent on the mains for operation and time-keeping. Recording instruments should be suitable for the removal of the previous day's record, and a well-designed tear-off bar is a desirable detail.

Secure operation of the supply system is dependent in the first place on good design and construction, but insulating materials may deteriorate, corrosion may affect conductors and contact surfaces, and apparatus may be misapplied and misused. Quite apart, therefore, from the possibility of accidental or deliberate damage to equipment, the risk of breakdown is always present, and early detection of any tendency towards failure is a real contribution to reliable supply. Devices for testing the condition of insulating materials and bushings and for detecting high-resistance line conductors and joints have received much attention, particularly with a view to obtaining ease of handling by " non-research " engineering staff, and in the result have been highly successful.

The analysis of conditions consequent on a system fault requires a thorough consideration of the load and fault current distribution, the significance of relay indications, and the value of the reports of witnesses. The Masson perturbograph has provided an excellent basis for examining the 50 c/s conditions prior to and during a fault, but even with fourteen of these instruments distributed throughout the country the individual records will often be so localised as to have a restricted analytical value.

Accurate fault location can save appreciable line inspection time, and can thereby speed up repairs and restoration to service. The method of location by reflected pulse technique has been successfully demonstrated, both here and on the Continent, and an extended trial is to be made by the South-Western Electricity Board. For the 132kV system very satisfactory results have been obtained for many years by measuring the transformer neutral currents over a short fixed interval, and calculating the fault position by reference to the zero-phase-sequence impedances of the system involved.

Measurement in Planning

As suggested earlier, the many measurements involved in preparing for the design of equipment, in obtaining efficient operation and in checking reliability, all combine to form the basis from which springs the plan for the future. Knowledge of the factors affecting one voltage level give some confidence for a venture to the next level. Information on the transmission of to-day's loads is used to justify proposals for dealing with those of to-morrow. The final test will be in the building and operating of the new system, but considerable guidance can be obtained from the model system—the network analyser. The d.c. analyser permits a first approximation analysis of load flows and short circuit conditions. The a.c. analyser carries the precision one stage further and allows a step-by-step examination of system operation and stability. More recently the *microréseau* of Electricité de France has provided a scale model of a machine system, both mechanically and electrically, which demonstrates realistically the effects of load variation and fault conditions.

Australian Engineering News

(From our Australian Correspondent)

Dearth of Cement

Lack of cement has made a serious impact on industry and very high prices have been obtained by unorthodox dealers. The Department of National Development states that the difficulty is not likely to be overcome before 1954. The Department also makes comment that in Victoria, inadequate supplies of black coal will probably prolong the shortage in that State. The report adds : " because most Australian cement works are now enlarging their capacities, it is expected that by 1953 the Australian manufacturing capacity will be 50 per cent greater than at present." Total capacity of all Australian cement-making plant is now estimated to be 80 per cent of the demand but actual production only 70 per cent, because of industrial troubles and insufficient transport. It has been calculated that by 1952–53 the Commonwealth should have an output of nearly 2,000,000 tons, which would still be less than requirements. The report also suggests that South Australian gypsum might be exploited for cement-making.

Siltation Problem at Newcastle (N.S.W.)

The situation which is developing in the important port of Newcastle, New South Wales, because of siltation, is causing much concern, and was recently the subject of a special exploration of the facts compiled by the *Sydney Morning Herald*. In the course of a long analysis the comment was made that : " The continuing outcry from Newcastle about siltation of the harbour and the acceptance last month of an overseas tender of £337,877 to dredge away some of the mud have emphasised again the serious consequences of soil erosion in the Hunter Valley. The big foreign tender is only a fraction of the full cost at Newcastle of the erosion process. It is merely an emergency step to supplement ceaseless efforts down the years to prevent the choking of the steel port by the silting up of its channels." It is further explained that in the last three years the incidence of siltation has reached a critical stage, being aggravated by the record rains and floods which have been experienced yearly since 1949. As a result, coal and steel ships built specially to operate from the port have been often unable to berth at the wharves equipped for handling their respective cargoes. It is added : " The project is to return the Hunter River Valley towards its natural condition by reafforestation, soil conservation, building of reservoirs to mitigate flood effects and enlarging the channels between Newcastle and Maitland. Work began in 1946 on Glenbawn, the first of eight major dams proposed, but shortages of manpower and materials have slowed progress, and to-day nobody will estimate when the eight dams will be completed. Meanwhile, the silt problem in the port requires urgent attention."

In view of the port's strategic importance, quick action is essential but one difficulty is the rather sultry atmosphere between the Labour Government of New South Wales and the Liberal Federal Government. The former, upon whom rests the responsibility for carrying out the necessary work, including also extension of dredging operations and the rebuilding and resiting of various wharves, takes the view that although the situation is apparent, its plans are hampered by shortages of manpower and materials ; a condition which it attributes to the policies of the Federal Government. However, as major industrial concerns, such as the Broken Hill Proprietary, Ltd., view the position with alarm and the people of Newcastle are clamouring for some quick constructive effort, it is hoped that there may be some acceleration of these projects.

Scheelite Developments

World-wide demand for scheelite and the expansion of rearmament programmes has caused the mining of scheelite in Australia to assume an importance, which, from the prospecting and investment standpoint, has become almost a rival of gold. The largest and most prominent enterprise is the King Island Scheelite Company, whose major property is situated on the island of that name, in Bass Starit, between the Victorian mainland and Tasmania. This company, whose production is being rapidly increased, is understood to have made long-term contracts with the United Kingdom and the United States. In addition, many mainland deposits which previously were not regarded as profitable enough to warrant exploitation have now gained a new lease of life and there is also much prospecting throughout the Commonwealth.

First Snowy River Hydro-Electric Contract

First major contract for the vast Snowy River hydro-electric and water conservation scheme is being granted to the Oslo firm of Selmor, which has carried out many similar projects in the hydro-electric developments in Norway. It is reported that the value of the contract is between £3 million and £4 million ; the outlay being part of the estimated total expenditure on what is known as the Guthega project, to cost about £6 million. It will add some 60,000kW to the total electric power capacity available to New South Wales and Victoria within the next three years. Turbines and generators supplied by British companies will account for more than £1½ million of the total cost. It is stated that 90 per cent of the labour and materials in short supply and necessary for the scheme will be brought from abroad, thus minimising its impact on the local labour and manufacturing market. The project, it will be recalled, affects the upper Snowy River, near Mount Kosciusko. The works include a dam on the river below its junction with tributaries from each side of the valley and also a tunnel, surge tank, pipe-line power-house and tail-race. The power-house will have an initial capacity of 60,000kW, with provision for another 30,000kW at a later date, when secondary benefit can be obtained from other storages higher up the river. The elevations at which the work will be carried out range from 5200ft to 4300ft above sea level. The dam will be 90ft high and the net head available about 800ft. Average annual flow of the river at the dam site is computed at 200,000 acre-feet and the spillway has been designed to discharge 25,000 cusecs. The tunnel will be about 3 miles in length and its designed capacity is 1520 cusecs. The Authority has undertaken the building of a road to the site from the headquarters town of Coome, which is 60 miles away, and 268 miles from Sydney. Housing for the workers is being erected at the site in anticipation of the start of the project.

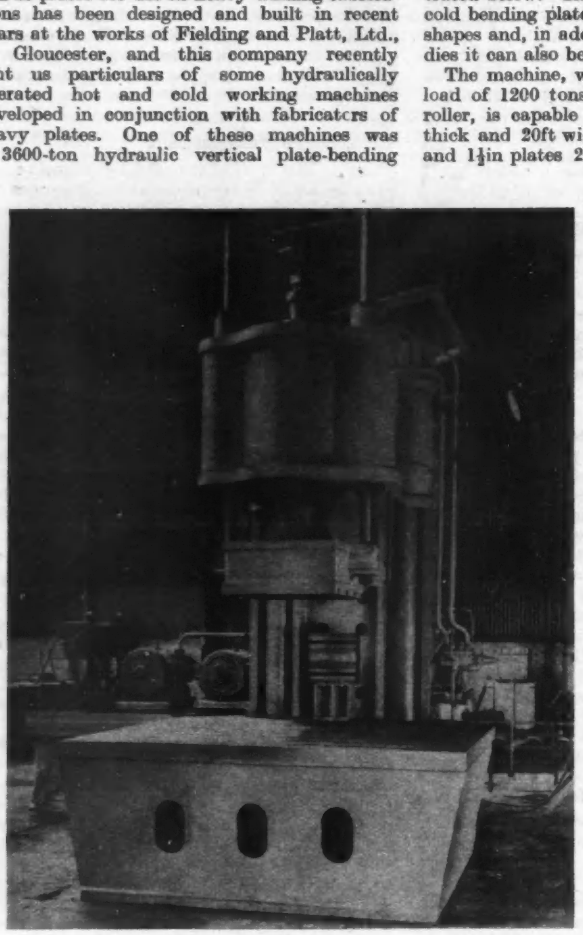
First Australian Diesel-Electric Locomotive

Recently the first diesel-electric locomotive to be built in the Commonwealth successfully underwent its trials near Sydney. The unit was built by the Clyde Engineering Company, of Granville, New South Wales, in collaboration with General Motors Corporation of U.S.A., which supplied the power equipment. The locomotive has a 1500 h.p. engine, weighs 108 tons and has a maximum speed of 90 m.p.h.

Heavy Hydraulic Presses

MUCH special equipment for the preparation of plates for use in heavy welding fabrications has been designed and built in recent years at the works of Fielding and Platt, Ltd., of Gloucester, and this company recently sent us particulars of some hydraulically operated hot and cold working machines developed in conjunction with fabricators of heavy plates. One of these machines was a 3600-ton hydraulic vertical plate-bending machine, for John Brown, Ltd., which is illustrated below. This machine is used for hot or cold bending plates to circular or semi-circular shapes and, in addition, by the use of blocking dies it can also be used for plate-edge bending.

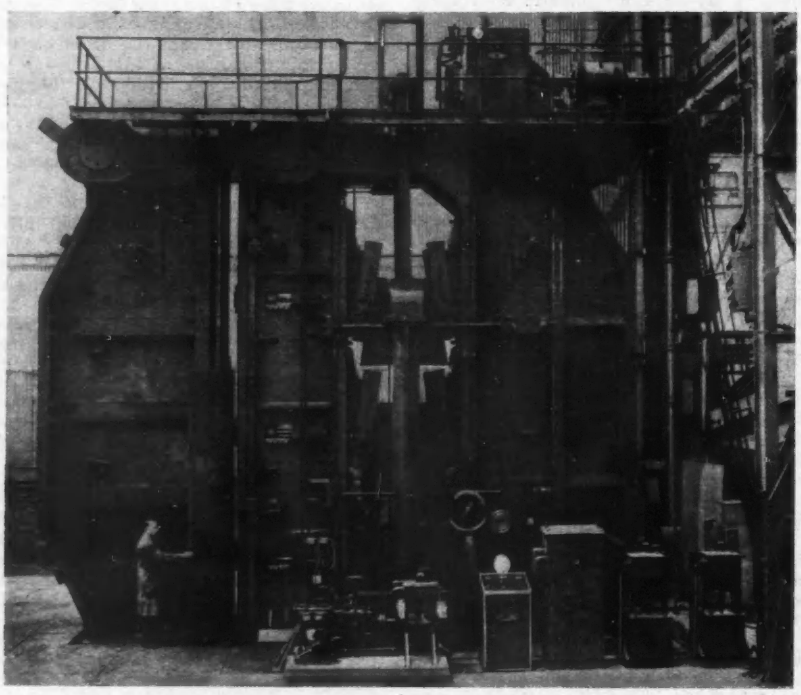
The machine, when working at a maximum load of 1200 tons and using a 35in diameter roller, is capable of cold bending plates 1¼in thick and 20ft wide to a circle 44in diameter, and 1½in plates 20ft wide to 40in inside diameter circles. When using a 12in diameter roller and the backing girder the maximum load of 3600 tons can be applied to cold bend 3in thick plates 20ft wide to half-circles 27in diameter and hot bend 5in thick plates 20ft wide to quarter circles 50in inside diameter.



750-TON HYDRAULIC FLANGING AND JOGGLING PRESS

Fabrication has been used largely in the construction of the machine, which consists of two end girders, one fixed and one moving, a top girder and a base-plate, which are secured together by heavy prestressed tension members The base-plate is accurately machined to support the main girders and the main hydraulic cylinders and bored to accommodate the bottom tension units.

Pressure is applied by three vertical main cylinders of equal power and means are provided in the hydraulic circuit to enable working loads of 1200, 2400 and 3600 tons to be selected, according to the particular operation required.



3600-TON HYDRAULIC VERTICAL PLATE BENDING MACHINE

The moving girder is traversed by wedges working on balanced rollers in conjunction with inclined planes. There are three wedges, those at the top and bottom being coupled together and operated by the two outer main rams of the hydraulic cylinders. The central wedge is operated from the centre ram and provision is made for this central wedge to travel slightly further than the two outer rams, so that it can adjust itself automatically to any deflection that may occur in the moving and fixed girders. In this way uniform loading of the moving girder is ensured, whilst the roller and inclined plane ensure parallel movement of the bending dies attached to the girder.

The base of the moving girder is carried on steel rollers to ensure freedom of movement and it is provided with forged steel keep pieces with gunmetal bearing strips as guides on the baseplate. These guides engage the bottom flange of the girder and take care of its vertical reaction. Bending dies on the moving girder are carried on hinged supporting members and the dies can be hinged clear to assist removal of the finished plate.

For bending very thick plates the machine is fitted with a 12in diameter bending roller, which is supported throughout its length by the fabricated backing girder. In this way a deep supporting section is provided, but the smaller diameter of the actual bending roller permits heavy plates to be bent to a relatively small radius. When using a 12in diameter roller assembly in conjunction with the removable backing girder, the roller revolves in two spring-loaded bearing assemblies at the top and bottom ends, drive to the roller being effected through an Oldham coupling, worm reduction gearbox and hydraulic transmission.

For the bending of thinner plates to smaller internal radii, the 12in roller and backing girder assembly can be removed from the machine and replaced by a single 35in diameter bending roller, which is provided with a similar arrangement for rotation to give the necessary plate feed. To facilitate the removal of finished drums from the machine, hinged tie-rods, which support the top of the roller assembly and backing girder in the down position, can be swung to a vertical position so that the finished plate can be lifted clear of the bending dies. To feed the plate progressively through the bending dies, hydraulically loaded friction rollers are used to hold the plate against the bending roller. On rotation of this roller by the requisite amount, the plate is fed progressively into the machine. Adequate interlocks are provided to ensure that the bending roller is stationary before the maximum bending power can be applied to the dies.

Hydraulic power is supplied by two of the maker's variable delivery, high-speed radial pumps, driven by 110 h.p. slip-ring induction motors, and the electrically controlled valve gear of the machine can be arranged either for automatic or hand operation. Inching control on all movements is provided and the circuit is arranged so that the stroke of the moving girder carrying the bending dies can be preset to give the requisite finished radius to the drum. This control is also interlocked with the plate feed mechanism.

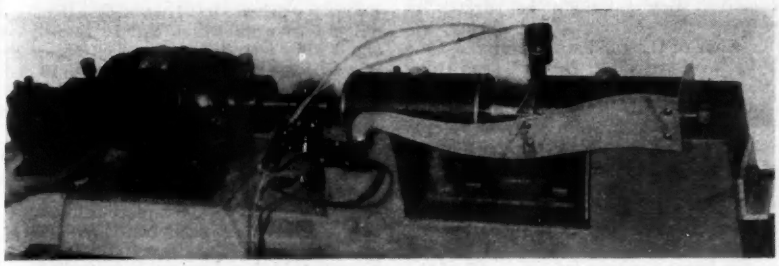
Our first illustration shows a recently completed 750-ton hydraulically operated open gap press for forming, flanging and joggling. This machine has a vertical ram with a stroke of 39½in and a working load of 750 tons and 150-ton horizontal ram with a stroke of 63in. Its bed is 158in by 118in and the vertical moving table is 48in square, whilst the horizontal moving ram has a 24in square table. The machine is built up of three main units consisting of a fabricated steel top table and bottom table and a cast steel centre frame or distance piece. In order to reduce the time between working cycles the vertical ram has a fast approach and return speeds of 500in and 350in per minute, respectively, through an air-loaded pre-filling system. Its pressing speed is 33in per minute. The horizontal ram has approach and pressing speeds of 75in per minute and a quick return speed of 400in per minute. Controls are effected through a hand lever control valve.

American Engineering News

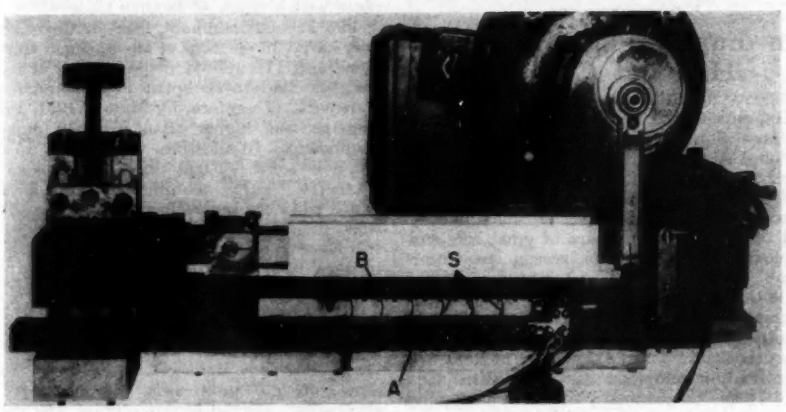
(From our American Correspondent)

New Metal Fatigue Testing Devices

Several devices, which have recently been constructed at the National Bureau of Standards, are proving valuable in accelerating metal fatigue tests conducted in the mechanical metallurgy laboratory of the Bureau. It is well-known that fatigue fracture occurs in two stages. In the first stage the metal is subjected to fluctuating stress until a small crack forms. In the second stage, the crack grows until the remaining cross section of the member is too small to support the applied load, whereupon complete fracture takes place. In fatigue studies it is usually desirable to determine the number of cycles of stress required to start the crack, as well as the number to complete the fracture. These determinations are facilitated if the testing machine can be stopped automatically once a small crack forms. Two stopping devices for this purpose have recently been put into operation at the Bureau.



FATIGUE TESTING MACHINE WITH DEFLECTION- AND VIBRATION-RESPONSIVE STOP



FATIGUE TESTING MACHINE FOR THIN SPECIMENS

One commonly used fatigue testing machine applies a bending moment to the specimen, simultaneously rotating it so that every point on its surface is subjected to a cycle which changes from tension to compression during each revolution. Mounted on such a standard testing machine, the two stopping devices developed respond to changes in the stiffness of the specimen when a small crack forms. In the machine shown in the upper illustration the specimen of 0·25in minimum diameter is drawn into spindles in bearing boxes. The bearing boxes are supported at the ends away from the specimen and are loaded at the ends near the specimen by weights hung on shackles. This loading results in a deflection of the bearing boxes and the deflection increases when a crack forms in the specimen. If the crack is only on one side of the specimen, the deflection will vary periodically with each revolution of the specimen, i.e., the bearing box will vibrate. Both the deflection and the vibration are used to actuate the stopping devices; one device is deflection-responsive and the other is vibration-responsive. The two stopping devices are used simultaneously at the Bureau, with their circuits connected in parallel; sometimes one will respond first, sometimes the other, depending on the peculiarities of the particular incipient crack. The deflection-responsive stopping device consists of a micro-switch operated by a lever. The lever is fastened rigidly to one of the bearing boxes and at the other end carries an adjusting screw, which bears on the actuating leaf of the micro-switch. After the machine has run long enough to reach temperature equilibrium, the adjusting screw is advanced until a very small change in the position of the lever will trip the micro-switch and shut off the machine. With careful adjustment, the arrangement has proved to be sensitive to cracks having a length of as little as 5 to 10 per cent of the circumference of the specimen. The vibration-responsive stopping device, which is fastened rigidly to one of the bearing boxes, consists of a steel ball poised on a three-pronged pedestal. Vibration resulting from an incipient crack in one side of the specimen shakes the ball from its perch; in falling, the ball closes an electrical circuit, which turns off the machine. The sensitivity of the device may be adjusted by varying the distances of the pedestal prongs from each other.

Because of the large deflection required, sheet metal of less than about 0·015in thickness cannot be fatigue-tested in bending, on commercially available cantilever testing machines. By deflecting the specimen as a column, a newly-developed fatigue-testing machine at the National Bureau of Standards makes possible the bending of specimens to a small radius of curvature without large amplitudes of motion in the driving mechanism. Because the machine holds several specimens at once considerable testing time may be saved. The device, which is shown in the lower engraving, was adapted from a Krouse Plate Bending Fatigue machine. Specimens (*S*), 1in high by ¼in wide, are held in place by grooves in two horizontal arms. While the lower arm (*A*) remains stationary the upper arm (*B*), pivoted at one end, is moved up and down at the other end by a crank arm and an adjustable eccentric. At the top of the crank throw the arms are parallel and the distance between the grooves equals the length of the specimens. When the upper arm is moved down by the crank the specimens are loaded as columns and assume bowed positions. Bending is greatest, of course, for the specimen nearest the crank. An automatic stopping device used with the machine takes advantage of the fact that after a crack forms the specimen no longer deflects in a smooth curve. An adjustable contact assembly is clamped to the lower arm of the machine and adjusted so that the intact specimen nearest the crank just fails to touch the contact disc at its maximum deflection. Cracks tend to form near the centre of the specimen, and when a crack starts a "hinge effect" causes the middle of the specimen to deflect more and make contact with the disc. This contact operates an electronic relay, stopping the machine. When a group of identical specimens are set up in the machine, the one nearest the crank, since it is subjected to the highest range of stress, will break first. After this specimen has been removed and the number of cycles recorded, the contact assembly is moved to the next specimen and the machine is restarted. Since as many as seven specimens can be tested at once, the fatigue properties of a material can be determined over a wide range of maximum strain values in a relatively short time.

Construction of Eklutna Tunnel in Alaska

A contract for the construction of a 4-mile-long, 9ft diameter transmountain water diversion tunnel and other facilities on the Eklutna Project in Alaska has been awarded by the U.S. Bureau of Reclamation to Palmer Constructors, of Omaha, Nebraska. It is the first major contract ever awarded by the Bureau for construction work on a reclamation project outside the mainland of the United States, although smaller contracts previously had been let for housing and electric transmission lines for use in connection with the Eklutna Project. Besides the tunnel, which will be driven through Goat Mountain to Knik Arm, an inlet of the sea, the contract also calls for the construction of a 9ft diameter concrete gate shaft, a concrete surge tank 30ft in internal diameter, and a penstock tunnel, with installation of a steel penstock varying from 7ft 6in to 6ft inside diameter. The contractor also has to make certain alterations to the existing Eklutna Dam. The Eklutna Project is the first item in a comprehensive programme for the conservation and multiple-purpose use of the water resources of Alaska. The project is expected to make available more than 164,000,000kWh of firm and non-firm electric energy for the Anchorage area. The power development in the region is based on the diversion of Eklutna Creek, situated about midway between the towns of Anchorage and Palmer. A glacier retreating up the Eklutna Valley left a natural dam across the creek, creating Eklutna Lake, which is 7 miles long and 200ft deep. Power will be produced by means of a tunnel through a narrow mountain, which intervenes between the lake and the sea, a penstock down the mountainside and a power plant at tidewater level. The plant will be situated on the Anchorage-Palmer Highway and will have a capacity of 30MW.

An Aircraft Carrier for the U.S. Navy

The Newport News Shipbuilding and Dry Dock Company has been awarded a contract for a 1040ft, 59,000 ton, flush-deck aircraft carrier, which will have a maximum beam of 252ft. Delivery is expected within three years, and the ship will be named "James Forrestal." Her keel is expected to be laid in 1952. She will be driven by steam turbines and fed by oil-fired boilers, although provision to convert her to atomic power has been mentioned. Her cost is estimated at 218,000,000 dollars. The new ship is designed to take the place of the 65,000 ton carrier "United States," whose construction was cancelled in 1949. The U.S. Navy has been said to place more emphasis on the ship's ability to handle larger and heavier jet fighters and patrol bombers and less on its ability to launch atomic bomb-carrying aircraft.

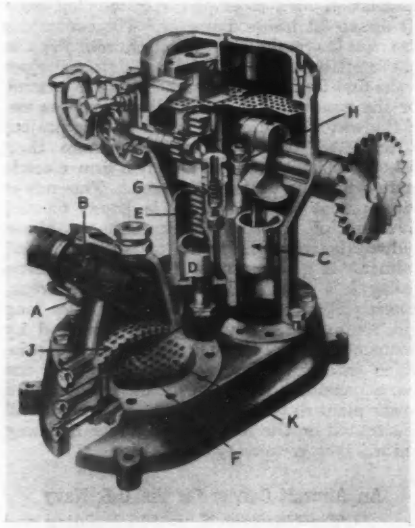
A Variable Capacity Pump for Corrosive Fluids

THE arrangement of a new pump which has been developed by Ames Crosta Mills and Co., Ltd., of Moss Iron Works, Heywood, Lancs, is to be seen in the illustrations we reproduce on this page. The pump is particularly intended for handling acids, alkalies, viscous and corrosive fluids, and it has a variable capacity of up to 7 gallons per minute. In the design which has been adopted the fluid is carried through the pump in a rubber tube and no part of the

MOTOR DRIVEN PUMP

pump mechanism or the oil used for transmitting its pulsations come into contact with the corrosive fluid.

The flexible rubber tube *A* in the pump has a non-return valve at each end and is coupled directly at its inlet and outlet to the fluid pipeline. This tube lies in an oil reservoir in the pump and is subject to alternate pressure and suction by the action of the oil. Pressure imparted to the oil by the pump compresses the tube and drives the fluid it contains into the delivery side of the pipe-line via a non-



ARRANGEMENT OF PUMP MECHANISM

return valve. Subsequent release of the oil pressure allows the tube to open and draw a charge of fluid from the inlet side of the pipeline through a non-return valve *B*. The amplitude and frequency of the impulses transmitted through the oil control the rate of the fluid flow.

Impulses are imparted to the oil by the pump piston *C*, which has a fixed stroke and is driven at a set speed. The magnitude of the impulses is controlled through a floating piston *D*, which is free to travel between an adjustable upper stop and a fixed lower stop. The upper stop is mounted on a rack *E* and, by setting this rack through a handwheel on the side of the pump, the length of piston float is controlled. When the floating piston is allowed a movement equal to the stroke of the pumping piston, no impulses are produced in the oil for transmission to the rubber tube. If the floating piston is pushed down by the rack and held on the lower stop a full volume of oil is forced into the reservoir at each pump stroke to impart the maximum impulses to the fluid in the tube. As the floating piston can be arrested at any intermediate position by the adjustable stop, the volume of oil moved and thus the rate of discharge from the rubber tube, can be varied.

The oil is actually contained in two separate reservoirs divided by a diaphragm *F*, which is allowed a restricted movement by perforated limiting faces. Thus there is a primary oil reservoir between the pistons and the diaphragm and a sealed secondary oil reservoir above the diaphragm and surrounding the rubber tube. It will be appreciated that if a single reservoir were used without the intermediate diaphragm, any change in volume of the oil transmitting the impulses, such as might be caused by leakage past the pistons, would change the mean position of the tube walls and the tube would be overstressed. Leakage can take place past the pistons and any change of volume is automatically adjusted by the spring-loaded ball valves *G* and *H*. An increase in the volume of primary oil causes the diaphragm to be pressed against the limiting face *J* before the piston *C* completes its full stroke and the excess oil is forced through the relief valve *G*. Similarly, any loss of oil is replenished under suction through the valve *H* after the diaphragm touches the lower limiting face *K*. All of the moving parts are surrounded by oil which ensures adequate lubrication and reduces wear.

An Engineering Exhibition Hall and Cinema

A PRIVATE exhibition hall and cinema has been equipped by Babcock and Wilcox, Ltd., at Salisbury Square House, Salisbury Square, London, E.C.4, to provide facilities for showing the extensive range of steam-raising equipment which the company manufactures.

Modern boilers and much of the auxiliary plant of the boiler-house are of great size and complexity, and for this reason are often assembled for the first time into a complete installation, actually at the site. The demonstration of such equipment therefore presents difficulties, since it can often be seen only in part at the maker's works, which are at Renfrew, in Scotland, or completed at widely distributed sites. Hence the company makes considerable use of sectionalised models and of films and other media, and they can be conveniently centralised in the new exhibition hall which is in close proximity to its head office in Farringdon Street.

This permanent exhibition is now available for the company's own use throughout the whole year and it forms a valuable complement to any public engineering exhibitions in which the company may take part.

The hall is fully equipped for the showing of 16mm sound (or silent) films, and in it comfortable seating accommodation is provided for an audience of up to eighty people. The main hall is 60ft long by 30ft wide.

The hall at present contains a display of models of modern Babcock power station boilers and marine boilers and an exhibition sequence illustrating and describing the part played by the company in the development of the water-tube boiler. This sequence includes copies of the original British patent of Babcock and Wilcox for their water-tube boiler, dated 1873, the early patent drawings, and photographs of George Babcock and Stephen Wilcox, also the original medallion presented to the firm for its exhibit of a water-tube boiler at the Paris Exposition in 1889.

BLACK COATING ON STEEL ARTICLES.—A new factory has been opened by Tool Treatments (Chemicals), Ltd., in Colliery Road, West Bromwich, for processing steel articles to impart a black oxide coating which does not peel, crack or alter the product physically or dimensionally. The process is intended to replace plating or enamelling and impart an attractive black finish.

French Engineering News

(From our French Correspondent)

Gaz de France has published a report of the progress of its modernisation plan for the first six months of 1951. This work included the closing down of eleven old gas plants and the reconstruction of four others; work was also being carried out on seventeen other plants, including three in the Paris area. Some 130km of new pipe mains were laid during the six months and 98km were brought into service. The pipe laid was tied into feeders at Corbeil-Fontainebleau, Metz, Pont-à-Mousson, Reims-Epernay, Orléons-Beaugency and Marseille-Aubagne. At Gerardmer a propane plant came into service. For the whole of 1951, it is pointed out, no more than 14·5 milliard francs will be spent on modernisation and new installations. The original plan provided for the expenditure of about 24 milliards. Also the rise in raw material prices has seriously reduced the amount of work which can be carried out on the credits provided. For 1952 Gaz de France will ask for 25·6 milliard francs, 18 milliard of which will be used for work which has already been sanctioned by the Modernisation Plan Commission. The feeder which will enable Paris to draw gas from the eastern regions of France, will not be ready until 1953.

* * *

France now takes fifth place in the hierarchy of world merchant fleets compared with eighth in 1939. In 1950, 181,000 tons of shipping were launched compared with 47,000 tons in 1938, and from the point of view of tonnage under construction France has the second place with a figure of 486,000 tons.

The French merchant fleet, however, could only carry 39 per cent of the national traffic in 1949, and 115 million dollars worth of foreign currency had to be spent in 1950 on foreign transport. Therefore, by May 1, 1951, French tonnage was higher than in 1939, but still insufficient. In addition, vessels over 15 years old now total 952,000 tons, and tankers and "Liberty" ships acquired at the Liberation which will need replacement amount to 725,000 tons, making a total of 1,677,000 tons, which will have to be replaced. During 1951, 190,000 tons of new construction will be completed, 190,000 tons launched and 80,000 tons laid down. A further 35,000 tons is shortly to be ordered, but French shipyards are far from being completely occupied. Reconstruction of the large shipyards damaged during the war is now complete and nearly so for the smaller shipyards. During reconstruction, the various yards have been modernised to employ welded and prefabrication construction methods. Expenditure on reconstruction and modernisation has amounted to 24 milliard francs (1950 value), the sum contributed by the State being about 9 milliards.

* * *

A meeting between the French steel makers and the French Coal Board resulted in a promise from the latter that fuel would be delivered to steel plants with no more than six months' delay. The usual delay is between twelve and even eighteen months. The meeting was necessary, as the steel position here was threatened by the fuel shortage. The problem will not be completely solved, however, until more scrap, of which there is a very serious lack at the moment, becomes available.

* * *

The Chantiers Naval de la Ciotat has announced the launching of the 4200 tons "Viet Nam." This ship will be used on the Messageries Maritimes lines. The plates of the vessel have welded butts and riveted seams, and the frames are riveted. Most of the ship was prefabricated and part of the superstructure is in light alloy.

The "Viet Nam" has two sets of turbines, built by the Ateliers et Chantiers de Bretagne. They develop a maximum of 24,000 s.h.p. and have a normal power of 19,500 s.h.p. Each turbine is driven by steam at 60kg pressure and 480 deg. Cent, supplied by three boilers built by Penhoet, two of which are sufficient to run the ship. A Lascroux funnel, which keeps the decks clear of smoke, is fitted to the ship.

Industrial and Labour Notes

Engineering Wages

A conference between representatives of the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions was held in London, on Wednesday of last week, on the claim for an all-round wage increase of £1 a week, submitted recently on behalf of adult male workers in the engineering industry. The claim was presented to the Employers' Federation on October 10th, following a decision by the annual conference of the Confederation of Shipbuilding and Engineering Unions to proceed with it.

After a full day's discussions last Wednesday week, the Employers' Federation made an offer of an increase of eleven shillings a week of forty-four hours to all adult male workers, together with an offer of an additional week's paid holiday. It was stipulated that the accumulation of payment in respect of next year's additional holiday would begin from the time when an agreement was reached. The union representatives indicated that they would have to put the proposals before a meeting of the Confederation's general council, which had been arranged to take place at York on Wednesday of this week.

At the beginning of the week it was announced that the national committee of the Amalgamated Engineering Union had recommended acceptance of the employers' offer of an eleven shillings a week increase. It may be recalled that the claim for a £1 a week increase originated from a decision taken at the annual meeting of the A.E.U. national committee last June.

Railway Wages

In these notes in our last issue, we recorded the acceptance by the three railway unions of the wage award of the Railway Staff National Tribunal. The award recommended an 8 per cent increase in the wages and salaries of about 442,000 railway employees.

Last week the Railway Executive announced that it had decided to accept the tribunal's award, the cost of which would amount to about £14,200,000 in a full year. The Executive stated that there was no possibility of making further savings by special economy measures or other means to meet that additional expenditure, and it was therefore advising the British Transport Commission to apply to the Minister of Transport for permission to increase freight charges. The last increase in railway freight charges was made on April 17th last, when they were raised by 10 per cent. The last increase in railwaymen's wages was made in February of this year and was retrospective to January 1st. It represented a rise of about 7½ per cent in the then existing rates of all grades, the estimated total cost to the Railway Executive being about £12,000,000 a year.

Iron and Steel Production

The British Iron and Steel Federation has announced that, during October, the output of steel ingots and castings averaged 300,600 tons a week, or an annual production rate of 15,629,000 tons. In October last year steel output was running at an annual rate of 17,040,000 tons. Over the first nine months of the current year, production was at an annual rate of 15,628,000 tons.

Pig iron production in October averaged 189,700 tons a week and was thus at an annual rate of 9,865,000 tons, compared with an annual rate of 10,084,000 tons in October, 1950. Taking the first nine months of this year, pig iron output was at an annual rate of 9,527,000 tons.

British Overseas Trade

The Board of Trade has stated that exports of United Kingdom goods in October reached a record value of £235,200,000. There were more working days in October than in September and the daily rate of exports was about 2 per cent above the average for the third quarter of this year. In the first ten completed months of the year exports were equivalent in value to an annual rate of £2,558,000,000, or 18 per cent above the total for 1950. After a reduction in September, imports in October rose to £362,600,000, a figure which was about the same as the high level ruling in June, July and August. With re-exports in October valued at £10,500,000, the excess of imports over total exports in the first ten months of the year amounted to £1,042,000,000.

The Board of Trade says that exports from this country to the U.S.A. in October were valued provisionally at £11,800,000, which was £2,200,000 above the low September figure, and about 4 per cent above the average for the third quarter of this year. Exports to Canada, valued at £10,300,000, also showed an improvement on the low September figure, although they were 21 per cent below the average for the third quarter. The total value of British exports to North America in October, at £22,100,000, was 9 per cent below the average for the third quarter, but 11 per cent above the monthly average for 1950.

Manpower for Rearmament

A question addressed last week in the House of Commons to the Minister of Labour, Sir Walter Monckton, asked what steps it was proposed to take to fill the vacancies in the labour force required by the rearmament programme. The Minister said, in reply, that various steps had been agreed by his predecessors with representatives of industry. Those steps included first the development of schemes of training and upgrading; secondly, collaboration with employers and trade unions in the quick redeployment of redundant labour; thirdly, more employment of older workers and, fourthly, the development of the part-time employment of women who were not available full-time. The Minister went on to say that he was examining the whole position and that he had been assured of the co-operation of all sides of industry in helping to solve the problem. There was, he added, no question of the introduction of powers of direction, except in the case of grave emergency.

An Autumn Management Conference

The Autumn Management Conference of the British Institute of Management was held at Harrogate from Thursday, November 15th, to Sunday, November 18th, and was presided over by Sir Hugh Beaver, who has succeeded Sir Charles Renold as chairman of the Institute. At the opening plenary session, on Thursday evening, the speaker was Sir Clive Baillieu, who presented a "Management Progress Report." In it, Sir Clive summarised the work of the committee, over which he had presided and which was set up to advise upon steps which needed to be taken to form a central institution for all questions concerned with management. Sir Clive then surveyed the principal activities of the British Institute of Management since its foundation in April, 1948.

In the course of his address, Sir Clive emphasised that technical knowledge and skill was still essential for the management of many industries and always would be, but, he said, they could be ineffective unless accompanied by management skills and techniques. Manpower and material resources, Sir Clive observed, were limited and would remain so, though there was a constant need for more and better goods and services, not only for our own consumption, but also for export and rearmament. The rearmament drive indeed overshadowed all else and it would need superhuman efforts to fulfil defence commitments without seriously reducing standards of living. Sir Clive said that it was to management that the country looked for those superhuman efforts. It was the task of management to provide the goods and services that the country required, with the most economical use of resources of all kinds—not only to develop and provide the technical means, but to inspire the workers to put their fullest efforts into the job.

The International Materials Conference

The Ministry of Materials has recently published some information about the work of the International Materials Conference in Washington, which has now been in existence for about ten months. The conference consists of a central group and seven commodity committees. The central group now has a membership of ten, including representatives of eight countries, and of the Organisation for European Economic Co-operation and the Organisation of American States. The commodity committees have completed a statistical review of materials supply prospects and general allocations for sulphur, copper, zinc, nickel, cobalt, tungsten and molybdenum have been announced. The Ministry says that, for the fourth quarter, the United Kingdom has accepted a "consumption allocation" of 102,300 tons of sulphur, 101,000 tons of which will be imported. The total amount is a reduction of 4000 tons on the third quarter allocation. The sulphur committee has also recommended ways of increasing sulphur production and conserving supplies and member-governments of the Conference are now reporting to the committee on steps which have been taken to implement the recommendations. For tungsten and molybdenum fourth quarter distribution in the United Kingdom has been arranged at 690 metric tons of tungsten and 538 metric tons of molybdenum. The first allocations of nickel and cobalt for the fourth quarter should ensure that this country receives 5088 metric tons of nickel and 329·1 tons of cobalt. It is not proposed, at present, to allocate manganese.

The commodity committee, which deals with copper, zinc and lead, has made allocations to the United Kingdom in the fourth quarter of 91,960 metric tons of copper and 60,250 metric tons of zinc, which, the Ministry of Materials says, can be considered reasonable in view of the serious world supply situation of these metals. Lead is not allocated at present.

British and American Steel Prices

In its *Monthly Statistical Bulletin*, the British Iron and Steel Federation has lately published a summary of developments in the American iron and steel industry and has given a comparison of British and American steel prices. A point of particular interest about the American steel industry has been the steady rise in prices which are now just about double what they were at the end of the war. Moreover, there is general expectation of a further advance before long.

The steep rise in American steel prices, which occurred between 1946 and the early part of 1949, was followed by a period of relative stability, owing largely to the recession in business activity generally, until the Korean war initiated a fresh advance. In the United Kingdom steel prices showed only a very gradual upward trend until the increase made in April, 1949, which was due in part to the transfer from the Exchequer of the losses on imported raw materials and semi-finished steel. Even after that advance, most steel products were appreciably cheaper here than in the U.S.A. After the devaluation of sterling, in September, 1949, British steel prices were shown to be, on a comparable dollar basis, substantially below the American level.

Figures presented in the *Bulletin* indicate that American home trade prices, so far as many descriptions of steel are concerned, are still one-third above the British level. British steel prices, of course, still do not fully reflect the sharp rise in the cost of imported raw materials.

Notes and Memoranda

Rail and Road

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—The council of the Institute of Road Transport Engineers has announced that the Institute has been incorporated under Section 19 of the Companies Act, 1948, and that henceforth the word "Limited" is dropped from its title. The headquarters of the Institute have been moved to 69, Victoria Street, Westminster, London, S.W.1 (telephone, Abbey 6248).

RUNWAY EXTENSION.—The extended main runway at Ringway Airport, Manchester, was formally opened last week. The extension of this runway from 1400 yards to 1966 yards, together with the associated taxi-tracks and the reconstruction of the terminal apron, was begun by the Ministry of Civil Aviation in August, 1950. This airport uses S.B.A. and G.C.A. equipment amongst its navigational aids, and the I.L.S. aid is shortly to be available, along with a high-intensity approach lighting system.

Air and Water

"BRABAZON" NIGHT FLIGHT.—The Bristol "Brabazon I," Mark I, recently made her first night flight from Filton airfield. Normal runway lighting was used and results were entirely satisfactory.

SEPTEMBER AIR TRAFFIC.—Air transport movements at United Kingdom aerodromes in September, 1951, numbered 20,970, 5·6 per cent less than the September, 1950, figure. The number of passengers handled, including those in transit, was nearly 343,000. At London Airport 96,107 passengers were handled, while at Northolt passengers handled totalled 102,472. Nutts Corner handled 16,803, Prestwick 16,608, Renfrew 16,364, and Jersey Airport handled 33,558 passengers during the month.

CAR FERRY.—Silver City Airways, a company operating with Bristol "Freighter" aircraft, whose Lympne-Le Touquet air ferry service carried 13,000 cars over the Channel during the season recently ended, are to begin a similar additional service between Eastleigh, Southampton and Maupertus, Cherbourg. One reason for making a start during the winter months is to make the service known before the normal ferry season opens, and another is to develop air freight traffic between the two ports. At first two aircraft will be used, operating an hourly service. This company had been granted a ten-year operating licence for the Lympne-Le Touquet route by the Ministry of Civil Aviation.

EMERGENCY AIR LIFT.—A recent military operation was the transport to Tripolitania of nearly 4000 British troops replacing Guards units suddenly drafted to the Suez Canal Zone from stations in North Africa. The operation began at 9 a.m. on Friday October 26th, when the first "Hastings" aircraft, carrying forty-two troops each, with complete kit and small arms—a total load of about 11,000 lb—took off from Lyneham for its seven-hour journey. Within seven days eighty-one sorties were completed. For the greater part of the operation the "Hastings," which are fitted with Bristol "Hercules" engines, were taking off at two-hourly intervals, with a two-hour turn-round at both Tripolitania and Lyneham. Crews were slipped at each terminal. Throughout the entire operation—comprising over 1100 flying hours—every aircraft took off and landed on schedule.

Miscellanea

SPIEGELEISEN PRICE INCREASE.—The Minister of Supply has made a new order increasing the basis price of spiegeleisen from £18 15s. 9d., to £22 per ton. The order, known as the Iron and Steel Prices (No. 4) Order, 1951, came into effect on November 19th.

PEAT PRODUCTION IN SWEDEN.—A committee of experts has recently presented a plan to the Swedish Government for increasing the country's peat production. A scheme for the next three years envisages an annual output of 400,000 tons. The plan proposes intensified research, long-term marketing guarantees and Government loans, and improved mechanised production methods, to stimulate the rationalisation of the industry.

PATENT No. 658,500.—Under the heading "Tools and Workshop Appliances," in our Patents column on November 9th, we published an abstract of Patent Number 658,500, Bolt Adaptors, by Henry Lindsay, Ltd., of Queen's Road, Bradford. That firm now informs us that this patent application has taken so long to come through that in the meantime its address has changed and is now Mansfield Road, Bradford, Yorkshire.

POTENTIALITIES OF WIND POWER GENERATION IN ISRAEL.—We learn from the British Electrical and Allied Industries Research Association that U.N.E.S.C.O., as part of a programme of assistance to small nations, has asked Mr. Golding to advise the Government of Israel as to the best methods of exploring the potentialities of wind power for electricity generation in that country. The problem of sources of power is one of great difficulty to countries such as Israel, so that sources which may be uneconomic elsewhere have to be taken into account.

CEMENT AND CONCRETE ASSOCIATION'S LECTURE COURSES.—The Cement and Concrete Association is holding three similar training courses, entitled "Modern Developments in Concrete Technique," at its training centre at Wexham Springs during November and December. Each of the three courses lasts for five days and includes lectures covering many aspects of concrete technology, and practical demonstrations. The Association states that it has endeavoured to include every possible modern development in the syllabus of the course. Further details may be obtained from the Association at 52, Grosvenor Gardens, London, S.W.1.

SYMPOSIUM ON NOTCH BAR TESTING.—The Joint Committee on Materials and Their Testing, in association with the Institute of Welding, is arranging a symposium on "Recent Developments in the Notch Bar Testing of Materials and their Relation to Welded Construction." It will be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, on Wednesday, December 5th, beginning at 10 a.m. Advance copies of all the papers to be discussed are now available. The joint secretaries of the committee—from whom full particulars of the symposium can be obtained—are Mr. G. Parsloe and Mr. G. H. Ford, 2, Buckingham Palace Gardens, London, S.W.1.

ATOMIC HEATING AT HARWELL.—At the Ministry of Supply Atomic Research Establishment, Harwell, a building containing eighty offices now draws its heat direct from BEPO, the large experimental atomic pile. Tests with the new installation have been successful and eventually two and perhaps three more buildings will also have "atomic radiators." The constant hot water is obtained by placing a heat exchanger in the outlet air duct of the pile's air-cooling system. Here there is a by-pass fitted with a damper, which can be adjusted to vary the proportion of the air flow passing through the heat exchanger. Hot water from the exchanger is then circulated in a closed circuit by a small pump to a secondary water-to-water heat exchanger. This supplies hot water for space heating and domestic hot water supplies. The heat output designed for the first building is 1,000,000 B.Th.U. per hour, but for the final installation the maximum output will be 7,000,000 B.Th.U. per hour. The total floor area now being heated is 32,000 square feet and the volume of space is 330,000 cubic feet.

RETIREMENT OF F. DE B. HART.—We learn that Mr. F. de B. Hart has retired from his executive duties with British Insulated Callender's Construction Company, Ltd., but will retain his seat on the board of directors. Mr. Hart received his initial training at Faraday House and, after short periods of service with the Newcastle Electricity Supply Company and Stanley Bros. Colliery, Bedworth, he joined the former Callender's Cable and Construction Company in 1911 as an assistant engineer on contract work. One of the contracts for which he was responsible involved the construction in Hungary of a 110kV 80-mile long overhead line, which was one of the first lines in Europe at such a high voltage. In 1929 he was appointed contract manager in the company's overhead department and, in 1942, he was made chief construction engineer in the civil engineering department. When the B.I.C.C. group was formed in 1945 he was appointed manager of the group's civil engineering department. Later, when the Group's subsidiary construction company—British Insulated Callender's Construction Company, Ltd.—was formed in 1949, Mr. Hart was appointed an executive director and joint manager of the developments and special projects department.

Contracts

HEAD WRIGHTSON AND CO., Ltd., Thornaby-on-Tees, has received a contract from the Appleby-Frodingham Steel Company for the construction of an ore preparation plant at Scunthorpe, Lincs. The plant is designed to deal with 3,750,000 tons of ore annually.

Personal and Business

MR. JACK GREGORY has been appointed a director of General Refractories, Ltd., Sheffield.

MR. S. A. SCADDING has been appointed publicity officer of J. and H. McLaren, Ltd., Leeds.

MR. PERCY W. HOWARD has been appointed managing director of the British Tyre and Rubber Company, Ltd.

MR. A. MCEWAN, M.I.Struct.E., has been appointed a director of Chamberlain Industries, Ltd., Staffa Works, Leyton, E.10.

MR. LAWRENCE HALPIN and Mr. John H. Osborn have been appointed directors of Samuel Osborn and Co., Ltd., Clyde Steel Works, Sheffield, 3.

MR. C. T. ROBERTS, B.Sc. (Eng.), M.I.Mech.E., M.I.Loco.E., has been appointed carriage and wagon engineer, Western Region, British Railways.

THE PENINSULAR AND ORIENTAL STEAM NAVIGATION COMPANY announces the Commodore of the fleet, Captain G. S. Stable, will retire on December 21st.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that its Hull branch office will be moved on November 26th to 199, Anlaby Road, Hull (telephone, Hull Central 16367).

BRITISH RAILWAYS, North Eastern Region, announces that Mr. W. R. Mosby has been appointed Assistant Signal Engineer, Signal and Telecommunications Engineer's office, York.

MR. J. C. CARR, C.B.E., who has retired from the post of principal assistant secretary in the Ministry of Supply, has been appointed a director of Thomas Summerson and Sons, Ltd., Darlington.

ALUMINIUM WIRE AND CABLE COMPANY, Ltd., has opened a Midlands branch office at Great Western Buildings, 6, Livery Street, Birmingham, 3 (telephone, Birmingham Central 5370).

THE BRITISH ELECTRICITY AUTHORITY states that Mr. W. H. C. Pilling, B.A., M.I.E.E., has been appointed chief generation engineer (construction) in the Merseyside and North Wales division.

THE BRITISH ALUMINIUM COMPANY, Ltd., announces that its head office will be moved, on December 1st, to Norfolk House, St. James's Square, London, S.W.1 (telephone, Whitehall 7868).

GREENHAM EQUIPMENTS, Ltd., Greenford, Middlesex, announces the appointment of Mr. Gordon Moseley as representative for Middlesex, Oxfordshire, Bedfordshire, Hertfordshire and Buckinghamshire.

THE BRITISH BROADCASTING CORPORATION announces the appointment of Mr. James Cleland as engineer-in-charge of the Kirk o' Shotts television transmitting station. Mr. W. L. Nicoll has been appointed assistant engineer.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., states that Mr. M. Gaughan, A.M.I.E.E., has been appointed to the Government and Railway Section of its lamp and lighting department at Mazda House, Fitzroy Road, London, N.W.1.

MR. W. TAYLOR-BAILEY has been appointed president and managing director of Dominion Bridge Company, Ltd., Lachine, Quebec, in succession to the late Mr. W. F. Angus. Mr. A. H. Cowie has been appointed vice-president and general manager of the company.

ASSOCIATED COMMERCIAL VEHICLES, Ltd., 49, Berkeley Square, London, W.1, announces the following appointments: Mr. A. S. C. Chattey, personal assistant to the chairman of A. C. V. Sales, Ltd., retaining his present office of director of home sales; Mr. C. A. Compton, assistant managing director.

MARBELLO AND DURUS, Ltd., and the Concrete Case Hardening Company, Ltd., announce that Mr. D. R. Snape has been appointed contracts manager for both companies. Mr. J. W. Russel, M.I.Struct.E., 2, Grosvenor Place, Newcastle upon Tyne (telephone, Jesmond 372), has been appointed technical adviser and agent for the Northumberland, Cumberland and Durham area.

THE ROYAL DUTCH PETROLEUM COMPANY announces that Mr. B. Th. W. van Hasselt has resigned, for health reasons, from the position of director-general and also as a managing director of the Royal Dutch/Shell group. As a result, Mr. L. Schepers has been appointed a managing director of the Anglo-Saxon Petroleum Company, Ltd., of the Shell Petroleum Company, Ltd., and of the N.V. de Bataafsche Petroleum Maatschappij.

British Patent Specifications

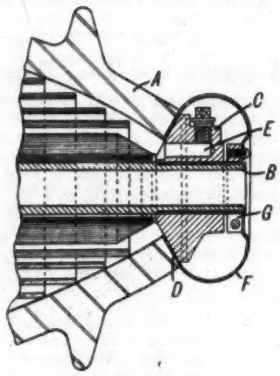
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

ELECTRICAL ENGINEERING

659,222. May 17, 1949.—HIGH VOLTAGE ELECTRICAL INSULATING BUSHINGS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2, and Philip Ashley Ewer, of 44, Blenheim Road, Walthamstow, London, E.17.

This invention relates to the rounding off or screening of projecting metal parts so as to avoid the formation of corona. In the drawing the conducting member *B* is centred within the porcelain shell *A* by means of a collar *C* presenting a frusto-conical surface at *D*, against which the end of the porcelain shell abuts, a suitable gasket being provided at the joint. The collar *C* is provided with a passage *E*, closed by a plug, by which the filling of the bushing with insulating liquid can be effected. In order that the projecting end of the conducting member may present a smooth external contour, it is provided with a metal bell *F*, which is



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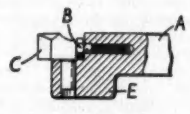
secured either to the collar or, as shown, to the conducting member by means of a clamp *G*. The metal bell is shaped to co-operate with the collar and forms an extension of the surface. The porcelain shell is constructed with a taper near the joint and the frusto-conical surface at the joint is made approximately normal to she wall of the tapering porcelain shell. The curved surface of the rim of the metal bell is thus virtually tangential to the frusto-conical surface so that these surfaces merge together at the point at which the bell leaves the external wall of the porcelain shell.—*October* 17, 1951.

WORKSHOP TOOLS AND APPLIANCES

659,134. April 21, 1949.—LATHE OR LIKE TOOL HOLDER, The O.K. Tool Company, Inc., of Delaware, United States of America, and Shelton, Connecticut, U.S.A.

The drawings show the holder head with a bit in place. There are three main parts; the holder *A*, the screw *B* and the bit *C*. The shank of the holder is made to fit in an ordinary tool post. It has an enlarged "L"-shaped head *E* with a



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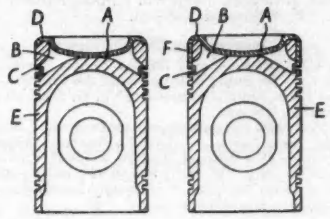
seating face and a hole for the mounting of the bit *C*, the stem of which enters the hole. The back face of the bit is spaced from the front wall slightly more than the thickness of the head of the cap-screw *B*. By backing out the cap screw with a wrench, its head can be brought to bear with any desired degree of pressure against the bit, thereby securely retaining it.—*October* 17, 1951.

INTERNAL COMBUSTION ENGINES

659,127. April 8, 1949.—COMPOSITE PISTONS FOR INTERNAL COMBUSTION ENGINES, John Francis Butler, Herbert Frank Percy Purday and Sir Frederick Ernest Rebbeck, all of Harland and Wolff, Ltd., Queen's Island, Belfast, Northern Ireland.

The drawings show views of composite pistons showing alternative ways in which invention can be applied. In the left-hand view a thin shell *A* made of heat-resisting material surrounds the combustion space and is connected by means of ribs *B* to an annular piston ring carrier *C*. The shell is extended at *D* to the periphery of the piston body *E*, cast into and around the



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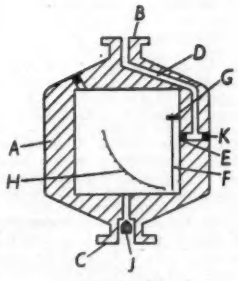
parts *A*, *B* and *C*. In the right-hand view the entire outer surface of the crown of the piston from the combustion space to the annular piston ring carrier *C* is formed of one piece of heat-resisting material by an integral cylindrical connection *F* between the parts *C* and *D*. With the construction shown the ribs *B* may be retained for added strength or may in some cases be omitted since the heat-resisting part of the piston and the body part interlock even without the ribs.—*October* 17, 1951.

INSTRUMENTS AND TESTING PLANT

658,868. February 16, 1949.—FLOWMETER, John Stephen Coane, of "Eden Vale," Parker Avenue, Hodge Lane, Hartford, Cheshire; and Imperial Chemical Industries, Ltd., Imperial Chemical House, Millbank, London, S.W.1.

This invention relates to a flowmeter for measuring rates of liquor flow of less than 10 cubic metres a day, such as are used, for example, in the sealing glands of pumps. As illustrated in the drawing, the body *A* is a hollow casting with a glass window in front and behind and channels for liquor flow. It is attached to an inlet pipe at *B* and an outlet pipe at *C*. Liquor flows in through the channel *D* and the orifice *E*. The flapper *F* hangs from the knife edges *G* which form part of the body, and the liquor forces it to rise by an amount depending on



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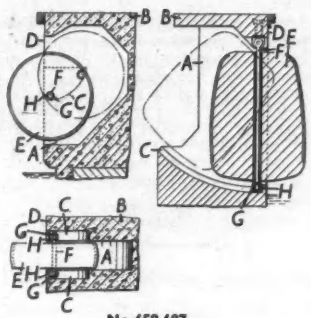
the rate of flow. The deviation of the flapper is shown on the scale *H*. In the event of any flow of liquor being forced back by disturbances in pressure, the stopper *J* in the outlet pipe rises and blocks the pipe. By making this stopper lighter than water it blocks the pipe before any actual return flow occurs. If the instrument is required for two or three times the rate of flow which can be shown by the position of the flapper on the scale, the orifice can be changed by unscrewing the plug *K* and replacing the orifice plug by one with a different sized orifice. Instruments of this type always require standardising, and fine adjustment of the deviation of the flapper for a given set of conditions can be effected by slightly altering the position of the orifice relative to the fulcrum. In order to use standard orifices and standard scales the flowmeter is standardised by setting the distance of the orifice from the fulcrum by rotating the orifice plug until the calibration of the instrument is correct.—*October* 17, 1951.

CIVIL ENGINEERING

659,687. September 2, 1949.—BERTHS FOR SHIPPING, Christiani and Nielsen, Ltd., 54, Victoria Street, Westminster, London, S.W.1, and Johannes Nissen, of Orstedhus, Copenhagen, Denmark.

This invention relates in particular to a fender for use in shipping berths. As shown in the drawing on the left an opening *A* is formed in the wall *B* of a berth for a ship, and in the vertical sides of the opening guide surfaces *C* extend from a point in close proximity to the face *D* of the berth and are curved in an upward direction towards the top and back of the opening, the guide surfaces being of substantially concave form. The fender comprises a disc or cylinder *E* which may be constructed from reinforced concrete, steel or other heavy material. From each end of the cylinder there extends a support axle *F* on each end of which is a sleeve bearing *G*. The cylinder is inserted into the opening in the berth with the sleeve bearings resting on the concave surfaces of the inclined guides *C*. At the outer end of the guides adjacent the face of the berth



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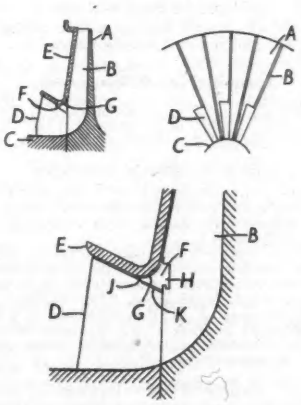
there is provided for each guide an abutment *H* against which the sleeve bearings are arrested when no ship is moored to the berth. When a ship moves in towards the berth its side engages the periphery of the cylinder and the momentum is absorbed by the weight of the cylinder, which is moved bodily upwards into the opening in the berth as the ship closes against the face. In order that the axle shall not be subjected to too great a pressure, the final impact of the ship is preferably absorbed by fixed tenders adjacent to the top of the berth. The surface of the cylinder engaged by a ship may be covered with steel, wood, rubber or any other suitable material. Referring to the right-hand views, the fender comprises a member of substantially circular cross-section throughout its length. The specification also describes a fender whose axis remains substantially vertical at all times.—*October* 24, 1951.

COMPRESSORS AND BLOWERS

659,389. December 13, 1949.—RADIAL-FLOW BLOWERS AND COMPRESSORS, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

The invention aims at obviating design and manufacturing disadvantages in fitting an additional rotor. According to the invention, the arc of transition from the radial blade to the additional rotor blade, towards the closure cover on the suction side is formed by an inserted piece connected with at least one of the two blades. In the drawings like parts are denoted by like reference letters. *A* is the rotor disc of the radial-flow wheel, *B* the radial blade, *C* the additional rotor hub, *D* the additional rotor blades, and *E* the cover on the suction side. F is an insert with a transition arc *G*, which considerably simplifies the manufacture of the cover. As illustrated in the lower view, the insert *F* may be inserted into the radial blade by means of a foot *H*



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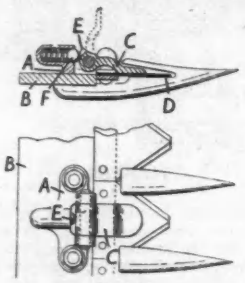
and soldered or welded to it. The insert is welded at *J* to the additional rotor blade *D* in order to prevent it rocking. A certain difference in expansion between the additional rotor blade and the radial blade is allowed for by a clearance *K*. Thus a radial-flow blower or compressor having an additional rotor is so arranged in that the arc of

transition from the radial blade to the additional rotor blade is formed, towards the closure cover on the suction side, by an insert connected to at least one of the two blades.—*October* 24, 1951.

AGRICULTURAL ENGINEERING

659,781. February 15, 1949.—PADS USED ON RECIPROCATING CUTTER BAR TYPE MOWING MACHINES, Allen and Simmonds (Auto-Culto), Ltd., Thames Side Engineering Works, Reading, Berkshire, and Francis James Bretherton, M.I.Mech.E., Grist Cottage, Mill Lane, Iffley, Oxford.

The device comprises a bracket *A* bolted to the cutter bar *B*, the bracket being formed with two lugs. On the pivot pin in the lugs is mounted a bossed end of a rocker arm *C*. The arm is curved downwards and its flat end engages on the knife *D*. On the rear of the boss arm is a cam-shaped nose or projection *E*. A spring loaded



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ball *F* on the bracket registers on the projecting nose. This ball presses against the nose to give sufficient leverage to depress the arm onto the knife in its normal working position. To withdraw the knife bar the arm is levered upwards on its hinge pin, as shown in dotted lines, for the plunger to engage the other face of the nose and hold the arm upwards clear of the boss on the knife bar.—*October* 24, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

British Society of Rheology

To-day, Nov. 23*rd.*—Institute of Physics, 47, Belgrave Square, London, W.1, "Soil Mechanics," J. Evans and P. Payne, 2.30 p.m.

Illuminating Engineering Society

Mon., Nov. 26*th.*—LEEDS CENTRE: Lighting Service Bureau, 24, Aire Street, Leeds, 1, "Hospital Lighting," J. K. Frisby, 7 p.m.

Wed., Nov. 28*th.*—Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, Report and Discussion on the 1951 Meeting of the C.I.E., 6 p.m.

Incorporated Plant Engineers

Tues., Dec. 4*th.*—Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Soil Mechanics," Mr. Wilson, 7 p.m.

Institute of British Foundrymen

Sat., Dec. 1*st.*—WALES AND MONMOUTH BRANCH: Engineers' Institute, Cardiff, "Patternmaking for General Engineering Castings," H. S. W. Brittain, 6 p.m.

Institute of Industrial Supervisors

Mon., Nov. 26*th.*—SMETHWICK SECTION: The Canteen, Guest, Keen and Nettlefolds (Midlands), Ltd., Smethwick, "Leadership on the Shop Floor," R. A. C. Radcliffe, 7.30 p.m.

Thurs., Nov. 29*th.*—ROTHERHAM SECTION: Technical Section, Rotherham, "The Cost Department and Supervision," 7.30 p.m.——NEWARK SECTION: Welbeck Hotel, Nottingham, "Foremanship To-day and To-morrow," J. R. Bergne-Coupland, 7.30 p.m.——GLASGOW SECTION: Royal Technical College, Glasgow, "Industrial Organisation from Craft to Trust," A. Jeffries, 7.30 p.m.

Institute of Marine Engineers

Tues., Nov. 27*th.*—85, Minories, London, E.C.3, "Automatic Combustion Controls for Marine Boilers," B. Taylor, 5.30 p.m.

Fri., Nov. 30*th.*—Technical College, Barrow-in-Furness, "The Construction of Oil Tankers," H. Armstrong, 7.30 p.m.

Institute of Petroleum

Thurs., Nov. 29*th.*—26, Portland Place, London, W.1, "Methods for Expressing the Viscosity-Temperature Relationships of Lubricating Oils," F. T. Blott and C. G. Verver, 5.30 p.m.

Institute of Road Transport Engineers

Mon., Dec. 3*rd.*—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Transmission," 7.30 p.m.

Institution of Chemical Engineers

Sat., Dec. 1*st.*—N.W. BRANCH: Radiant House, Bold Street, Liverpool, "Study of Carbide Furnace Operation," R. B. Peacock, 2.30 p.m.

Institution of Civil Engineers

Tues., Nov. 27*th.*—Great George Street, Westminster, S.W.1, "The Rapid Calculation of the Plastic Collapse Load for a Framed Structure," B. G. Neal and P. S. Symonds, 5.30 p.m.

Fri., Nov. 30*th.*—YORKSHIRE ASSOCIATION: Blue Bell Hotel, Scunthorpe, "Civil Engineering Aspects of Major Plant Developments at the Appleby-Frodingham Steel Company," K. Patterson, 6.30 p.m., preceded by a visit to the works of the Appleby-Frodingham Steel Company in the afternoon.

Institution of Electrical Engineers

To-day, Nov. 23*rd.*—N.E. STUDENTS' SECTION: Grey Hall, King's College, Newcastle upon Tyne, "Experiences on an Australian Distribution System," E. G. Williams, 6.30 p.m.

Mon., Nov. 26*th.*—RADIO SECTION: Savoy Place, London, W.C.2, Discussion on "Should Broadcasting be Superseded by Wire Distribution?" opened by P. P. Eckersley, 5.30 p.m.

Tues., Nov. 27*th.*—N. MIDLAND CENTRE: Lighting Service Bureau, 24, Aire Street, Leeds, 1, "A New Power Stroboscope for High-Speed Flash Photography," W. D. Chesterman, D. R. Clegg, G. J. Peck and A. J. Meadowcroft, 6.30 p.m.——LONDON STUDENTS' SECTION: Savoy Place, London, W.C.2, "The Use of Working Scale Models in the Development of Broadcasting Aerials," T. R. Boys, 7 p.m.

Wed., Nov. 28*th.*—SUPPLY SECTION: Savoy Place, London, W.C.2, "A Statistical Approach to Some Problems in Electricity Supply," R. B. Rowson, 5.30 p.m.

Thurs., Nov. 29*th.*—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Use of Saturable Reactors as Discharge Devices for Pulse Generators," W. S. Melville, 7 p.m.

Institution of Engineering Draughtsmen and Designers

To-day, Nov. 23*rd.*—LIVERPOOL BRANCH: Exchange Hotel, Liverpool, Special Branch Meeting, 7 p.m.——GLASGOW BRANCH: Royal Hotel Lounge, Glasgow, Special Branch Meeting, 7 p.m.

Institution of Mechanical Engineers

To-day, Nov. 23*rd.*—Storey's Gate, St. James's Park, London, S.W.1, "The Control of Boilers Fired by Solid Fuels in Suspension," Llewellyn Young, 5.30 p.m.——WESTERN BRANCH, GRADUATES' SECTION: College of Technology, Unity Street, Bristol, "Design Development of the Aircraft Gas Turbine," B. A. Peaster, 7 p.m.

Mon., Nov. 26*th.*—SOUTHERN BRANCH, GRADUATES' SECTION: Polygon Hotel, Southampton, "Measurement of Electrical Activity in the Human Body," J. C. Shaw, 6.30 p.m.

Tues., Nov. 27*th.*—S. WALES BRANCH: S. Wales Institute of Engineers, Cardiff, "Mechanical Engineering Features at Nantgarw Colliery," T. G. Dash and J. Petit, 6 p.m.——BIRMINGHAM A.D. CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Design and Development of Very Large Road Haulage Vehicles," C. E. Burton, 6.45 p.m.

Wed., Nov. 28*th.*—E. MIDLANDS BRANCH: Gas Showrooms, Lower Parliament Street, Nottingham, "Engineering and Metallurgical Problems in the Oil Producing Industry," H. K. M. Lloyd, 7.15 p.m.——YORKSHIRE BRANCH: The University, Sheffield, Illustrated Lecture making special reference to the engineering possibilities of Afghanistan, W. A. Abbott, 7 p.m.——LUTON A.D. CENTRE, GRADUATES' SECTION: George Hotel, Luton, "Performance Testing of Agricultural Tractors," P. H. Southwell.

Thurs., Nov. 29*th.*—WESTERN A.D. CENTRE: Royal Hotel, Bristol, "Some Factors Governing the Performance of Crankcase Lubricating Oils," A. Towle, 6.45 p.m.

Fri., Nov. 30*th.*—Storey's Gate, St. James's Park, S.W.1, "Cup Drawing from a Flat Bank: An Experimental Investigation," S. Y. Chung, 5.30 p.m.——SCOTTISH BRANCH: Robert Gordon's College, Aberdeen, "Some Milestones in a Hundred Years of Marine Engineering," Edward L. Denny, 7.30 p.m.

Institution of Structural Engineers

To-day, Nov. 23*rd.*—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Designing for Welding," F. Brooksbank, 6 p.m.

Thurs., Nov. 29*th.*—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, descriptions of some recent Midlands structures, 7 p.m.

Junior Institution of Engineers

To-day, Nov. 23*rd.*—39, Victoria Street, London, S.W.1, Annual General Meeting, to be followed by the Annual General Meeting of the Contributors to the Benevolent Fund, 6.30 p.m.

Mon., Nov. 26*th.*—SHEFFIELD AND DISTRICT SECTION: Co-operative Educational Centre, 201, Napier Street, Sheffield, 11, Presidential Address, "Vulcanalia," F. J. Sarjant, 7.30 p.m.

Fri., Nov. 30*th.*—39, Victoria Street, London, S.W.1, "Some American Windmills," Rex Wailes, 6.30 p.m.

Liverpool Engineering Society

Wed., Nov. 28*th.*—24, Dale Street, Liverpool, "The Manufacture and Application of Mineral Wool," A. M. Macgregor, 6 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Nov. 23*rd.*—Mining Institute, Neville Hall, Newcastle upon Tyne, "An Analysis of Ship Vibration Using Basic Functions," J. E. Richards, 6.15 p.m.

Wed., Nov. 28*th.*—STUDENT SECTION: Bolbec Hall, Newcastle upon Tyne, "The Development of Mining Machinery," T. Thompson, 6.45 p.m.

Royal Aeronautical Society

Thurs., Nov. 29*th.*—Institution of Civil Engineers, Great George Street, London, S.W.1, "Structural Problems in Advanced Aircraft," H. H. Gardner, 6 p.m.

Royal Institution of Great Britain

To-day, Nov. 23*rd.*—21, Albemarle Street, London, W.1, "Radio-Astronomy," J. A. Ratcliffe, 9 p.m.

Royal Society of Arts

Wed., Nov. 28*th.*—John Adam Street, Adelphi, London, W.C.2, "The Whaling Industry," Edward Hindle, 2.30 p.m.

Sheffield Metallurgical Association

Tues., Nov. 27*th.*—Grand Hotel, Sheffield, "Vermiculite as a Fuel Saver," K. W. Cowling, 7 p.m.

Society of Engineers

Mon., Dec. 3*rd.*—Geological Society, Burlington House, Piccadilly, London, W.1, "Some Aspects of Industrial Filtration," R. E. Gray, 5.30 p.m.

Society of Instrument Technology

Tues., Nov. 27*th.*—Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, London, W.1, "The Visual Presentation of Instrument Data," K. F. H. Murrell, 6.30 p.m.

Launches and Trial Trips

MALEKULA, cargo ship; built by Barclay, Curle and Co., Ltd., for Burns, Philip and Co., Ltd., Sydney; length 336ft, breadth 47ft, depth to shelter deck 27ft 6in; Kincaid-Harland-Burmeister and Wain two-cycle, trunk piston diesel engine, eight cylinders, 500mm diameter by 900mm stroke, 2200 b.h.p. at 150 r.p.m. Launch, October 22nd.

PORT TOWNSVILLE, cargo liner; built by Swan, Hunter and Wigham Richardson, Ltd., for the Port Line, Ltd.; length between perpendiculars, 460ft, breadth moulded 64ft 6in, depth moulded to upper deck 41ft 6½in, deadweight 10,790 tons on 28ft 9in draught; five holds, general cargo in two and three insulated; 5, 10 and 15-ton derricks and one 60-ton derrick; Wallsend-Doxford oil engine, six cylinders, 725mm diameter by 2250mm combined stroke, 7500 b.h.p. at 114 r.p.m.; three 295kW diesel generators; designed speed 15½ knots. Trial, October 22nd.

STANBURN, cargo liner; built by the Burntisland Shipbuilding Company, Ltd., for the Stanhope Steamship Company, Ltd.; length between perpendiculars 435ft, breadth 59ft 6in, depth moulded to shelter deck 38ft 11in, deadweight 10,350 tons on 25ft 10in draught; five holds, steam deck machinery; Hawthorn-Doxford oil engine, four cylinders, 600mm diameter by 2320mm combined stroke, 3300 b.h.p.; heavy oil fuel; one multitubular boiler and one vertical composite boiler. Trial, October 29th.

SANDALWOOD, motor tanker; built by Joseph L. Thompson and Sons, Ltd., for John I. Jacobs and Co., Ltd.; length between perpendiculars 475ft, breadth moulded 67ft 4½in, depth moulded 37ft 4in, deadweight 15,300 tons; N.E.M.-Doxford oil engine, four cylinders, 670mm diameter by 2320mm combined stroke; service speed 12½ knots. Launch, October 30th.

PORT NELSON, cargo liner; built by Harland and Wolff, Ltd., for the Port Line, Ltd.; length between perpendiculars 460ft, breadth moulded 64ft 6in, depth moulded to upper deck 41ft 6in, 8375 gross tons; five main holds, some being insulated, served by two 15-ton, eight 10-ton and two 5-ton derricks; Harland-Burmeister and Wain single-acting, two-cycle, opposed-piston oil engine, seven cylinders, 750mm diameter by 2000mm combined stroke, 112 r.p.m.; two vertical multitubular boilers, three 295kW diesel generators. Trial, October 31st.

CROYDON, motor collier; built by the Burntisland Shipbuilding Company, Ltd., for the South-Eastern Gas Board; length between perpendiculars 264ft 6in, breadth 39ft 6in, depth moulded 18ft 6in, deadweight 2825 tons, draught loaded 17ft 1in; British Polar diesel engine, eight cylinders, 340mm diameter by 570mm stroke, 1150 b.h.p. at 225 r.p.m. Launch, November 1st.

ESKWOOD, cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for the Constantine Shipping Company, Ltd.; length between perpendiculars 214ft 6in, breadth moulded 35ft 4in, depth moulded 16ft, deadweight 1675 tons, draught loaded 15ft 8½in; three cargo holds with portable divisional bulkheads; British Polar two-cycle, trunk piston, airless-injection diesel engine, four cylinders, 340mm diameter by 570mm stroke, 640 b.h.p. at 250 r.p.m. Trial, November 5th.